THURSDAY, MARCH 25, 1915.

PSYCHOLOGY WITHOUT CONSCIOUSNESS.

Behavior: An Introduction to Comparative Psychology. By Prof. J. B. Watson. Pp. xii+439. (New York: H. Holt and Co., 1914.) Price 1.75 dollars.

BY the nature of its subject-matter, psychology has been more handicapped than any other science as regards both methods and aims. This is a truism which may qualify the following statement of Prof. Watson: "Psychology has failed signally during the fifty odd years of its existence as an experimental discipline to make its place in the world as an undisputed natural science." He is quite justified in saying that psychology "as it is generally thought of, has something esoteric in its methods. If you fail to reproduce my findings, it is not due to some fault in your apparatus or the control of your stimuli, but it is due to the fact that your introspection is untrained. . . . If you can't observe 3—9 states of clearness in attention, your introspection is poor. If, on the other hand, a feeling seems reasonably clear to you, your introspection is again faulty. You are experiencing too much." This kind of psychological method has been particularly exploited by the Germans. Again, the science has almost evaporated "in speculative questions concerning the elements of mind, the nature of conscious content (*e.g.*, imageless thought, attitudes and *Bewusstseinslage*, etc.)"; a practical result is that the concept of sensation is "unusable, either for the purpose of analysis or that of synthesis." Generally, the axiom that psychology is a study of the phenomena of consciousness has been thoroughly mischievous; no data have been accorded any importance except in so far as they throw light upon conscious states. Compromises have been attempted; a line has been tentatively drawn where "associative memory" in animals begins; consciousness has been assumed to commence where "reflex and instinctive activities fail properly to conserve the organism," or "whenever we find the presence of diffuse activity which results in habit-formation, we are justified in assuming consciousness." Not the least result of such pre-suppositions is the divorce of the study from practical human interests.

The new school of what Prof. Watson terms "behaviorism" has, as his volume well shows, thrown overboard much conceptual lumber of the sort sketched above, and comparative psychology is able to act untrammelled. "It is possible to write a psychology (as the 'science of behavior') and never go back upon the definition; never to use the terms consciousness, mental states, mind, content, will, imagery, and the like. . . . It can be done in terms of stimulus and response, in terms of habit formation, habit integration, and the like." The starting-point is the observable fact that "organisms, man and animal alike, do adjust themselves to their environment by means of hereditary and habit equipments; . . . . certain stimuli lead the organisms to make the responses." Thus, with the elimination of investigational reference to consciousness, mental state, or imagery (as previously such reference to soul and mind (its successor) had been discredited), the barrier between psychology and objective sciences is removed; "the findings of psychology become the functional correlates of structure and lend themselves to explanation in physico-chemical terms." "The behavior of man and the behavior of animals must be considered on the same plane."

This latest reforming of the comparative psychological front may be considered strategically sound, and should lead to advances along all the line. Little has been accomplished yet, but the resulting clearness of objective is already promising. For instance, Prof. Watson's discussion of the differences between man and animal; convolution of brain surface probably means nothing *per se*. Wundt assumed that the apperception centres resided in the frontal lobe; for this view there is no probability, but since the frontal lobe "was the last brain tissue put on in evolution, and is to be found chiefly in man, we have hastened to assign to its care all those functions in which man is thought chiefly to excel the brute." The break between man and brute is "the lack of well-developed speech mechanisms in animals and the consequent lack of *language habits*. . . . The lack of language habits forever differentiates brute from man."

The general reader and the beginner in comparative psychology will find this impartial and well-reasoned volume invaluable. Some of the best matter is the result of the author's own experiments, *e.g.*, with terns, monkeys, and rodents.

A. E. CRAWLEY.

WATER, SEWAGE, AND FOOD.

(1) *The Chemical Examination of Water, Sewage, Foods, and other Substances.* By J. E. Purvis and T. R. Hodgson. Pp. 228. (Cambridge: At the University Press, 1914.) Price 9*s.* net.

(2) *Water Supplies: their Purification, Filtration, and Sterilisation. A Handbook for the Use of*

Local and Municipal Authorities. By Dr. S. Rideal and Dr. E. K. Rideal. Pp. xii+274. (London: Crosby Lockwood and Son, 1914.) Price 7*s.* 6*d.* net.

THESE two books to some extent supplement one another, the former dealing with the analysis of water (among other things), while the latter treats mainly with the production of a pure and wholesome water supply; the one being designed for the analyst and public-health student, the other for local and municipal authorities.

(1) The volume by Messrs. Purvis and Hodgson, as its name implies, deals primarily with the chemical analysis of water, sewage and foods, and such allied subjects as the detection and estimation of preservatives, and the analysis of air, coal-gas and other gases, rag flock, and urine.

The opening chapter, which is by far the longest in the book, deals with the analysis of water, sewage, and sewage effluents. More or less detailed descriptions are given of the chief tests employed, and in this connection one might note the desirability of the standardisation of some of these tests, notably those for albuminoid ammonia, and oxygen absorbed from permanganate. Some of the tests, as described, do not appear to be capable of any great delicacy. This is particularly the case with the ammonia tests, which apparently are about ten times less delicate than those employed in the laboratories either of the Metropolitan Water Board or the Royal Commission on Sewage Disposal.

At the conclusion of the chapter the results of a series of investigations, chiefly by Mr. Purvis, are given dealing with the effect of mixing sewage with river water and sea water. Much of the work is obviously inspired by the eighth report of the Royal Commission on Sewage Disposal. The researches have resulted in some interesting information, but the manner in which the results are presented makes a full appreciation of them very difficult, and some of the results of an investigation of the changes which occur to a mixture of sewage and sea water in course of time show such wide variations that one is inclined almost to doubt the accuracy of some of the figures; for example, the albuminoid ammonia of a mixture of sewage and sea water analysed after 115, 165, and 176 days is given as 0·078, 0·002, and 0·13 respectively (Table F[1], p. 74).

The remaining chapters of the book consist of instructions for carrying out the analyses of the other substances mentioned above. The instructions are usually remarkably clear and concise, but occasionally they become much involved and even ungrammatical, suggesting that these parts have been hurriedly compiled. This, however, is a small blemish, and can easily be corrected in a future edition; it in no way detracts from a book which will undoubtedly be of great value both to the analyst and the student in a public-health laboratory.

(2) The second volume under review deals with the question of water supply in its widest sense, and only touches on the subject of analysis in the last chapter, and then more on the interpretation of the results than on the way these results are obtained.

The opening chapters deal with the inorganic and organic contents of natural waters, both useful (as in medicinal springs) and harmful (as in water from polluted sources), mention being also made of some of the living contents, particularly those grouped under the name of plankton. Following this preliminary matter, the book deals with the successive stages in water supply under the headings of sources of supply, distribution, storage, filtration, softening, sterilisation, and finally the analysis of water and interpretation of results.

There is so much of interest in this valuable book that it is difficult, in the space allotted, to more than mention many of the important subjects dealt with, but several points call for especial notice.

The chapter devoted to storage is full of interesting information, particularly with regard to the physical, chemical, and bacteriological changes which occur in water subjected to storage. It is pointed out, for instance, that while the changes which occur to an initially impure water are wholly or mainly in the direction of improvement, an initially pure water may considerably deteriorate owing to prolonged storage.

Before going into the important subject of filtration, the authors devote a chapter to preliminary purification, including precipitation and assisted sedimentation, deferrisation, and the abatement of nuisances arising from living growths in the reservoirs; this subject is treated very fully, and reference is made to the work of many investigators both English and foreign.

Chapters vii. and viii. deal in great detail with the question of sand filtration and mechanical filtration, chapter ix. with softening, and then follow two important chapters on sterilisation.

The authors enter a strong plea for the sterilisation of all supplies from polluted or pollutable sources. Against the contention that the expense of sterilising is prohibitive in a great many cases, the suggestion is put forward that there might be a dual supply for drinking and non-potable purposes, but the arguments in favour of this course do not seem to be very convincing; moreover, the

alternative to sterilisation put forward by Dr. Houston in his reports to the Metropolitan Water Board—namely, adequate storage followed by efficient filtration—is not presented in its best light, and one is inclined to think a much better case could be made out from Dr. Houston's reports in favour of his suggestions than is conveyed by the somewhat meagre extracts given in the book.

The different means of sterilising water are very fully described and discussed, both chemical (peroxides, excess lime, chlorine, and hypochlorites, etc.), and physical and electrical (electrolytic hypochlorite, ozone, and ultra-violet light), and full reference is made to the places where these processes are practised.

The concluding chapter, on the analysis of water and the interpretation of results, is written more for the water authority than the analyst. It is not an easy subject to deal with, yet the authors appear to have done it very carefully.

There are numerous excellent plates in the book illustrating different works and processes.

DENISON B. BYLES.

RADIOLOGY IN THEORY AND PRACTICE.

(1) *X-rays: an Introduction to the Study of Röntgen Rays.* By Dr. G. W. C. Kaye. Pp. x+252. (London: Longmans, Green and Co., 1914.) Price 5*s.* net.

(2) *A Manual of X-Ray Technic.* By Capt. A. C. Christie. Pp. viii+104. (Philadelphia and London: J. B. Lippincott Company, n.d.) Price 8*s.* 6*d.* net.

(3) *Molecular Physics.* By J. A. Crowther. Pp. viii+167. (London: J. and A. Churchill, 1914.) Price 3*s.* 6*d.* net.

(1) THE discovery of X-rays has hitherto afforded an opportunity, probably unique in the history of science, for the production of that kind of literature which is distinguished more for its sensational character than for its accuracy or usefulness. If the numerous small books and pamphlets dealing with the subject and published between 1895 and 1898 do not seem to us now to possess any striking feature, they are at least remarkable for their resemblance to one another. They serve, too, as a measure of the wide popular interest aroused by Prof. Röntgen's work. Some of these publications actually reached the six thousandth edition before finally sinking into oblivion. When it was realised, however, that X-rays, in conjunction with the study of radioactivity, were destined to play a vital part in the elucidation of many problems hitherto considered insoluble, and a few well-known laboratories had successfully taken the matter in hand, the budding heralds of a new physics seem to have lost their spirit. It is noteworthy that from about 1898 until now, excepting some medical works, including an account of radiation treatment, no English book has appeared devoted solely to the systematic study of Röntgen radiation.

Dr. Kaye's book will therefore be welcomed by all who are engaged in work with the new radiations generally and with X-rays in particular, for it has appeared at the very moment when it is most needed.

The time has certainly come to take stock of our knowledge of this subject and to set forth clearly the relationship which connects the speed of the electron with the wave-length of the radiation resulting from its impact against a specific substance. Incidentally, it is seen that the production of a radiation identical with the gamma rays from radium is merely a question of overcoming certain experimental difficulties, and obstacles of this character generally disappear with the lapse of time. The first part of Dr. Kaye's book deals in an interesting manner with some of the early classical vacuum-tube experiments, and care is taken, by the aid of numerous asides in the form of footnotes, to give the reader many useful facts as well as references.

The fourth chapter deals with the X-ray bulb itself, and the progressive changes in its design are traced from the 1895 type, with flat electrodes, up to the somewhat elaborate modern apparatus. There are many excellent illustrations here, and the photomicrograph on p. 43, of an anti-kathode after prolonged use, is of great interest. A chapter follows in which the various high-potential generators of electricity are described. The references to influence machines, induction coils, and step-up transformers contain many practical hints, and the oscillograph records are well reproduced. Next follows an account of the various interrupters and their several virtues or drawbacks, and a chapter dealing with the actual manipulation of an X-ray apparatus, wherein we are told about the volatilisation of the anti-kathode, the coloration of the glass, and so forth—all of great practical interest and importance to these engaged upon this work. The rest of the book is concerned with the more theoretical part of the subject and methods of measurement, questions of wave-length, sparking potentials, absorption coefficients, and so on. The work of Barkla and others on the secondary and characteristic radiations are fully set out, so that the reader may be gradually prepared for the final sections dealing with the actual nature of X-rays and the

discussion of recent work upon their reflection from the interior of crystals.

Although we do not agree with the footnote to p. 165, the application of X-rays to medicine is mentioned with a moderation which will be understood and appreciated by those who are expert in that branch of the subject. We have no hesitation in recommending that a copy of the book should be in the library of every medical practitioner who desires to master the fundamental ideas underlying the properties and actions of the radiation which he is putting to good use in the alleviation or cure of disease.

(2) The study of the clinical application of X-rays is more often than not approached from a purely medical point of view, and some there are who think that a wider scientific knowledge, especially of physics, should play a large part in the early training of the student of radiology. It is probable that with them at least this book will find no favour; indeed, were it not for the fact that the author states specifically in his preface, for whom this book is intended some doubt upon the point might reasonably have arisen.

It must be borne in mind, however, that we have to deal here with a manual intended to meet the "needs of the United States army," and, judging by the somewhat limited knowledge of the subject considered sufficient in our own service, a student who assimilates the contents of this work might be counted as one possessing exceptional qualifications.

If "brevity is the soul of wit," it may also be the source of much error, and the inadequate treatment of the elements of electricity and magnetism condensed into the first nine pages contains some misleading statements. From chapter iii. onwards, however, there will be found many useful practical hints as to radiographic technique, and the tersely written survey (which certainly covers a wide field) affords a suitable framework upon which to build by experience if supplemented by the study of more complete works dealing with the subject.

(3) It is noteworthy that in this small handy volume Mr. Crowther has succeeded in giving a remarkably complete survey of work dealing with the physics of the electron and atomic structure.

The treatment of the subject is naturally influenced very largely by the trend of researches carried out during the last few years at the Cavendish Laboratory, and the work therefore stands as an authoritative and connected account of the most important recent results which have emanated from Cambridge under the stimulating leadership of Prof. Sir J. J. Thomson. The new method of analysis, for instance, which depends upon the simultaneous deviation of positive particles by an electrostatic and magnetic field, is dealt with in considerable detail and the apparatus illustrated by photograph and diagrams. There are also chapters devoted to the nature and size of electrons, their group stability, cohesion, and adhesion, as well as the bearing of modern physics upon valency and other problems once thought to be the exclusive preserves of the chemist. In the midst of great detail the author has nevertheless marked out clearly the general lines upon which this important subject has rapidly developed in recent years, and has brought together into a connected whole the results of work from many sources. It is difficult to select any particular section for special mention where all are so well done, but the chapter dealing with the atom in vibration is certainly of particular interest.

The author then shows the far-reaching significance of these new experimental results by directing attention to their bearing upon the complex "molecular theory of matter" as applied to solids, liquids, and gases. In the later pages he refers to the kinetic theory of heat, the size of atoms, and many other questions of wide interest and importance at the present day. The book, so well conceived, is a veritable mine of information. It will be read by physicists with only one regret—the author has not included even the briefest index. C. E. S. P

OUR BOOKSHELF.

Economic Cycles: Their Law and Cause. By Prof. H. L. Moore. Pp. viii + 149. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 8*s.* 6*d.* net.

In this volume Prof. Moore has undertaken to test statistically the theory that the fundamental cause of that curious swing in trade, which results in alternate periods of depression and expansion instead of steady growth or decline, is a corresponding cycle in the weather, operating through its effect on the crops. Rainfall data for the Ohio valley are subjected to harmonic analysis, and the periodogram shows principal periods of thirty-three and eight years. These periods and their semiharmonics applied to the statistics of yield and production for some of the principal crops suggest that they will also account for the principal fluctuations in quantity, as might be expected from the high correlation between the yield and the rainfall of the months that are critical for each crop. Changes in yield are also highly correlated with changes in price for the several crops, and hence the general relation of the crop-cycle to the cycle of prices and trade in general—though matters are not so simple as might be thought at first sight, for in some manufacturing industries, *e.g.*, the production of pig-iron, price and production rise and fall together.

As in the case of his volume on the "Laws of Wages," Prof. Moore brings a distinct freshness of view to his task, and has made an important contribution to the subject with which he deals. What one most misses is any reference to the labours of others who have preceded him in the same field, and rendered the hypothesis one that many have already accepted, though some of them may only be willing to regard the weather-cycle as a contributory cause.

Directions for a Practical Course in Chemical Physiology. By Dr. W. Cramer. Second edition. Pp. viii + 102. (London: Longmans, Green and Co., 1915.) Price 3*s.* net.

THIS is a useful little laboratory manual, in which the author states he has departed from the method usually employed. This departure may be illustrated by an example; there are certain tests for starch; it is usual to take commercial starch and perform the tests with this; the student is generally instructed also to prepare enough starch from the potato to illustrate its microscopic appearances. Dr. Cramer adopts the method of starting with the potato, and instructs his pupils to prepare from it enough starch for macroscopic experiments also. The distinction between the two methods is rather apparent than real, and Dr. Cramer's method involves more trouble to the student, which may not be a bad thing. Another departure one notices is that the results of a reaction are not explained; he interpolates instead questions such as, what change occurs? or why is this? or explain the result. This plan of stimulating inquiry is an excellent one for the student above the average; but one fears that 95 per cent. of the class will leave the questions unanswered, and be content with their ignorance. The author, moreover, is not consistent in the use of this method of questioning; one notes, for instance, in such subjects as blood-clotting and nerve chemistry, subjects on which Dr. Cramer holds special views of his own, that the teaching is didactic; it would evidently be unsafe to leave students here free to pursue independent inquiry.

W. D. H.

Soil Conditions and Plant Growth. By Dr. E. J. Russell. Pp. viii + 190. New edition. Monographs on biochemistry. (London: Longmans, Green and Co., 1915.) Price 5*s.*

THE first edition of Dr. Russell's book was reviewed in the issue of NATURE for October 24, 1912 (vol. xc., p. 215). To the new edition a chapter has been added on the relationship between the micro-organic population of the soil and the growth of plants, and also a number of sections dealing with recent developments of other parts of the subject.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Early Figures of the Opossum.

IN view of the fact that several communications have appeared in NATURE during the past year concerning the first mention of the American opossum in literature, it may not be inopportune to direct attention to some of the early illustrations of this animal in maps and in printed works. First of all, it should be stated that the earliest reference to the opossum is found in the famous collection of voyages known as "Paesi Novamente Retrovati," published in 1507. In chapter cxiii. of that work it is mentioned that a live specimen, taken by the Pinzons in Brazil in 1500, was exhibited in Granada.

In the Waldseemüller map of 1516 a drawing intended to represent the opossum, as indicated by its accompanying legend, is introduced in the Brazilian region of South America; and this figure is copied in a number of later maps, and also in the Italian edition (1558) of Sebastian Münster's "Cosmographia."

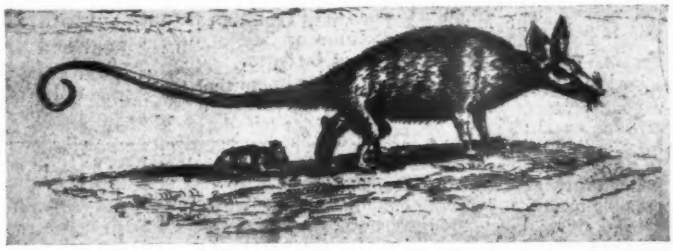

FIG. 1.

Under the native designation of "Su," a grotesque figure of the opossum was given by André Thevet, in his volume published in 1558, and in the same year appeared the "Wahrhaftig Historia" of Hans Stade, of Homburg, wherein occur (cap. xxxi.) two illustrations, and descriptions, of these Brazilian animals, one of which is called the "Servoy" (*Didelphis marsupialis*, L.) and the other "Dattu" (*Dasypus novemcinctum*). The descriptions read as follows:—

"There is also a kind of game, called servoy, which is as large as a cat, and has a tail like a cat; its fur is gray, and sometimes grayish black. And when it breeds, it bears five or six young. It has a slit in the belly about half a span in length. Within the slit there is yet another skin; for its belly is not open, and within this slit are the teats. Wherever it goes, it carries its young in the pocket between the two skins. I have often helped to catch them and have taken the young ones from out of the slit."

"There is another sort of animal found in this country which the savages call *dattu*; it stands about six inches high and is nine inches long; its body is covered all over, except underneath, with a kind of armor. This covering is horn-like, and the plates overlap one another like those of chain armor. This animal has a very long snout, and is usually found on rocks. It feeds on ants. Its flesh is sweet and I have often eaten of it."

Several species of American marsupials are figured by seventeenth-century writers, such as J. E. Nieremberg (1635), George Marcgrav (1648), César de Rochefort (1658), and others. An illustration given by the last-named author is here reproduced (Fig. 1).

C. R. EASTMAN.

American Museum of Natural History.

Differential Antiseptic Action of Organic Dyes.

AN important property of certain organic dyes is their differential antiseptic action. Thus, varieties of *B. coli* commonly met with in the intestine are more susceptible to the inhibitory action of the tetraethyldiamidotriphenylmethane derivative, "brilliant green," than are typhoid or paratyphoid bacilli. The use of a fluid culture medium containing this dye (along with telluric acid) facilitates greatly the isolation of scanty typhoid and paratyphoid bacilli from fæces, since the growth of the various members of the *coli* group can be restrained, while the organisms in question proliferate actively. The detection of cases of typhoid infection, *e.g.* in "carriers," which is frequently a difficult bacteriological problem, can be materially simplified by this procedure. But our supplies of brilliant green have hitherto been derived from Germany, and I shall be indebted to your readers for information as to whether this dye is prepared in a fairly pure state by anyone in this country.

C. H. BROWNING.

The Bland-Sutton Institute of Pathology,
The Middlesex Hospital, London, W.

The Physical Properties of Isotopes.

DR. LINDEMANN (NATURE, March 4) deduces that the vapour pressure of lead from radio-active origin, or of radium D, should be very considerably different from ordinary lead at comparatively low temperatures. It would be no easy matter to test this at such a low temperature as 100° C. However, it is being found possible to make measurements of the vapour pressure of cadmium down to 10^{-6} mm., and the method should be applicable to the point in question.

It is interesting to note in connection with the last paragraph of Dr. Lindemann's letter that the arc spectra of lead of radio-active origin and of ordinary lead show no difference, as Mr. T. R. Merton has recently found, further confirming the view that the external electrons are responsible both for the spectra and the individual chemical properties of elements.

ALFRED C. EGERTON.

19 Old Court Mansions, Kensington.

A Misprint in Halphen's "Fonctions Elliptiques."

HAVING recently had to use Halphen's multiplication formulæ for the special cases of the lemniscate functions ($g_3=0$), I have convinced myself that there is a rather serious misprint in his expression for ψ_4 (vol. i., p. 96), namely, instead of $+\frac{1}{3\cdot 2}g_2^3$ in the last term, we should read $-\frac{1}{3\cdot 2}g_2^3$. Thus with $g_2=4$, and this correction, we have

$$\psi_4=\wp'(-2\wp^6+10\wp^4+10\wp^2-2)$$
$$=-2\wp'(\wp^2+1)(\wp^4-6\wp^2+1)$$

where the factor $(\wp^2+1)$ can be foreseen from the theory. With the other sign we have no such resolution.

G. B. MATHEWS.

Early References to Musical Sands.

AN allusion to musical sands may be found in one of the tales from the "Arabian Nights"—"The Story of the Two Sisters who were jealous of their Younger Sister." Prince Bahman, who was journeying in search of rarities and treasures, reaches the foot of a mountain, and while ascending "was assailed with the most hideous sounds," while others who followed him heard "groans, shouts, and all sorts of insulting epithets." One of the wonders they were in search of was the "Singing Tree," which "commenced to issue a series of exquisite strains of music" as soon as the Princess Parizadé saw it.

CECIL CARUS-WILSON.

March 21.

TWO CHINESE TOURS.[1]

A SOMEWHAT unexpected sequel to the mission which Sir Francis Younghusband led to Lhassa in 1903–4 was the appreciation by Chinese officials of the fact that the trade in Indian opium, which has at times been held up as a reproach to England, was in reality due to the demand of China for the drug. It is interesting to reflect that the truth should first have dawned upon a Chinese envoy who had been educated in the United States. The novel idea took root and engendered a movement which spread in China with such rapidity that in 1906 an imperial edict dealing with the opium question was promulgated. This rescript embodied elaborate provisions for the immediate curtailment and the gradual extinction of the use of the drug. Necessarily, therefore, it took account not only of the enormous Chinese out-turn of opium, but of the smaller, though still important amount imported from India. Proposals and counter-proposals were accordingly formulated in 1907 by the Governments of China and Britain, and certain regulations, to remain effective for three years, were agreed upon by the high contracting parties and became operative in 1908.

Meanwhile the Government of the United States thought fit to initiate a movement of an international character which culminated in the assembly at Shanghai in 1908 of an opium commission, the findings of which reflect a desire to aid the Chinese authorities in their crusade against the opium habit; while, before the preliminary period of three years had expired, negotiations for a new agreement between China and the United Kingdom were set on foot. As a preliminary to the ratification of this agreement it was desirable that his Majesty's Government should know what had been the actual effect in China of the restrictive measures adopted there in response to the imperial injunctions of 1906. The officer to whom the important duty of reporting upon this feature of the case was Sir Alexander Hosie. No one better fitted for the duty of traversing the six provinces of China, known to have been the chief opium-producing areas in that empire, could have been selected. Sir Alexander had already travelled extensively, and in some cases, as an officer of the Chinese Consular Service, had resided in the provinces

[1] "On the Trail of the Opium Poppy. A Narrative of Travel in the Chief Opium-producing Provinces of China." By Sir Alexander Hosie. 2 vols. Vol. i., pp. viii+300. Vol. ii., pp. 308. (London: G. Philip and Son, Ltd., 1914.) Price 25s. net 2 volumes.

involved. During a sojourn of more than thirty years in China he had taken a keen interest in all the economic resources of the empire; he had, moreover, been one of the members of the International Opium Commission which met at Shanghai. The narrative and the results of the two official journeys, undertaken with the object of securing the information of which the British Government had need, are given in the volumes now before us.

As the author in his preface explains, the book is not devoted to the history of the opium question. Nevertheless, those interested in that question will do well to consult this work. The circumstance that such consultants may neither be inclined nor qualified to appreciate the whole of the contents has been forestalled by the provision, for their especial benefit, of a couple of appendices wherein the genesis of the anti-opium crusade is outlined, and the results of his own investigations of 1910–11 into the cultivation of the poppy are summarised.

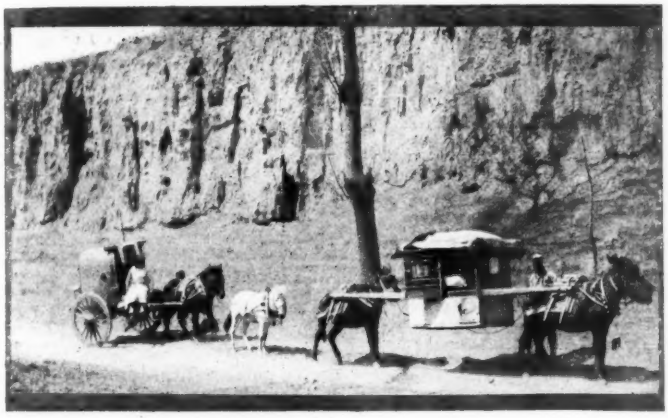

FIG. 1.—The loess formation, with mule litter and passenger cart, Shansi. From "On the Trail of the Opium Poppy."

FIG. 2.—Chinese ash (*Fraxinus Chinensis*) coated with insect white wax. From "On the Trail of the Opium Poppy."

As compared with various other accounts of recent Chinese travel, an outstanding feature of the present work is the extent to which it deals with the conditions and the appearance of long-settled and closely cultivated portions of that empire. Having regard to the primary purpose of his two journeys this was inevitable, nor can the reader be too grateful to the author for the care and precision with which he recapitulates the various crops observed in the course of a particular stage. Even in districts where tilth is most intensive, however, areas occur which are unfit for cultivation, and are under timber. The components of the vegetation in cases of this kind are as carefully assessed as the field crops. In one such passage the author warns the reader not to assume, because reference has been made almost exclusively to trees of economic importance, that species of less consequence were altogether absent. The same may be true of other stages, as to which no such reservation is made. But even when due allowance is made for this possibility, one of the most interesting impressions which the narrative of the author conveys is the extent to which species that are devoid of utilitarian interest and value have become eliminated. The naturally regenerated constituents of the woodlands on uncultivated mountain slopes appear in the main to be as strictly economic as the species planted along highways and irrigation channels.

The detailed descriptions of the various stages should render the work useful to those who may follow the author's route, but the general reader will be most interested in, and will profit most from, the incidental accounts of the configuration, the industries, and the polity of the provinces traversed by him. A passage which excites interest and arrests attention deals with the famous Nestorian tablet at Hsi-an Fu in Shensi, while the temperate but convincing reference to the shortcomings of European cartography, the uniformity and simplicity of Chinese delimitations and terminology notwithstanding, evokes the reader's sympathy. Space forbids more than a passing reference to a few of the interesting topics discussed in the work. Among these may be mentioned the cultivation of huskless grain, the use of the fibres quaintly known to European commerce as China jute and China grass, the preparation of varnish, the weaving of silk, the making of bamboo hats, the wood-oil industry, the smelting of copper, the mining of coal, the separation of salt, the planting of rice, the various contrivances for irrigation, the different types of bridges. With these and other equally interesting topics the reader may best be left to make himself acquainted by reading the book. One of the most interesting passages in the work deals with the familiar yet little understood *loess* formation (Fig. 1), so extensively represented in the area traversed during the author's northern journey. Another, taken from the southern journey, treats of the white-wax industry (Fig. 2),

for our knowledge of which we are mainly indebted to the author's powers of observation. These powers are so rarely at fault that it seems almost ungracious to indicate the only instance in which he appears to have been led into misapprehension; there is one passage in which what, from his succinct description, was obviously a silk-cotton tree has been confused with that—from a phytogeographical point of view—extremely interesting species, the tulip-tree of China. The book is admirably printed, and in its 600 or so pages we have noticed but one typographical error.

THE TELEPHONE IN SURGERY.

IN the *Lancet* of January 30 is published an address by Sir James Mackenzie Davidson, delivered before the Medical Society of London, on the telephone attachment in surgery. By this phrase the author refers to the attachment of a telephone receiver to a probe, or lancet, or other metallic instrument used by a surgeon when exploring a wound containing a bullet or other piece of extraneous metallic matter, in such a way that the sound heard in the telephone when the probe comes into contact with the bullet enables the surgeon to make certain of the position of the bullet in the wound.

As this matter appears to be of real importance at the moment to surgeons in the field hospitals of our armies abroad, we make no apologies for giving our readers a summary of the more salient features of Sir Mackenzie Davidson's address. His attention was first directed to the use of the telephone as an auxiliary in surgery thirty-two years ago, by the accounts of the attempts made by Graham Bell, to determine, by means of the induction balance, the position of the bullet in the body of President Garfield when he was assassinated in 1881. Speaking afterwards of these attempts, and of the difficulties attending the method—which had failed in that notable case to yield satisfactory indications—Graham Bell outlined another and simpler electrical method for the detection of bullets, as follows:—

> It consists of a telephone, to one terminal of which a fine needle is fixed, and to the other a plate of metal of the same nature as the needle. The plate is placed on the limb to be examined, and the needle is thrust in where the bullet is believed to be; and when it strikes the ball a galvanic battery is formed within the body. . . . *This will cause a click to be heard in the telephone each time the bullet is struck.* This is a far simpler apparatus than the induction balance, and one far more easily procured.

This method Sir Mackenzie Davidson tried in 1887 at the Aberdeen Royal Infirmary, in the case of a patient suffering from a revolver shot, using a silver probe joined by a wire to one terminal, and a silver plate, about 6 inches long and 4 inches wide, connected by wire to the other terminal of a telephone receiver. In subsequent years he employed the same method to verify the results of early X-ray localisations, and it enabled surgeons in the South African War to differentiate, as the common probe could not do, between a distorted and broken up Mauser bullet and a fragment of bone. Sir Mackenzie Davidson states that until quite recently he took it for granted that the same metal must be used—as Graham Bell stated—for the probing instrument and for the plate placed upon the patient's skin. But since the outbreak of the present war the difficulty experienced by skilful surgeons in finding bullets in wounds, even after the most precise localisation by means of X-rays, has caused him to experiment further, and to extend the method. Briefly, he finds, as the result of experimenting on different pairs of metals, that there is nothing so satisfactory as a plate of carbon, such as is used in an ordinary bichromate cell, to place upon the moistened skin of the patient as the auxiliary pole. The surgeon's metallic instruments are usually of steel, often silver-plated or nickel-plated. The metals to be sought for are lead, iron (and iron alloys), copper, and nickel. Carbon presents a sufficiently wide difference in its galvanic properties from any of these to render it suitable. The result is enhanced if the solution used to moisten the skin beneath the plate is the solution of iodine employed as a disinfecting agent, since iodine is also an excellent depolariser. A low-resistance telephone is better adapted than the more expensive high-resistance receivers used in wireless telegraphy, giving louder sounds besides being cheaper.

The form of telephone recommended is one with double receivers fixed to a flexible steel hoop that is placed on the head, so that each ear listens to its own receiver, and is protected from extraneous sounds. The operating surgeon places the auxiliary carbon plate upon the patient's moistened skin at some convenient spot near the place where the foreign object is supposed to be situated, and it may be held tightly against the skin by bandage or plaster. If a bare wire of silver is used as probe, it should, of course, be properly disinfected. Or the wire may be wound round an ordinary probe or needle or forceps which is used, or a spring clip may be employed to connect the instrument to the wire connected to the telephone. No battery of any kind is needed, owing to the galvanic action between the carbon-plate and the metal of the bullet. If, under these conditions, the instrument is introduced into the body of the patient, it will on the first contact with the bullet or other metallic body cause a most unmistakable click; while if the probe or scalpel is gently moved along the foreign body so as to make rubbing contact along it, an equally unmistakable rattling sound will be heard. Several examples of successful application, showing the advantages gained by the use of this method, are given by Sir Mackenzie, who states it to be his belief "that the time will come when no surgeon will attempt to remove a deeply embedded metallic body without having this telephone attachment at his command." He makes out an exceedingly good case for this application of the telephone to surgery.

The author's experience and ingenuity in applying X-ray methods to localise the position of foreign bodies are so well known that when he comes forward with improved methods of electric probing, which have the distinguishing merit of the utmost simplicity, we may be sure they will find immediate and extensive application.

GEODETIC SCIENCE.

NO. 3 of the new series of professional papers of the Ordnance Survey contains some excellent notes on the geodesy of the British Isles, by Colonel Close, R.E., which bring the position of geodetic achievement fairly up to date, and incidentally add some historical indications of the processes by means of which our position in the world of geodetic science has been secured. Their usefulness has been increased by the addition of a very ample bibliography of the science, and by simple diagrams illustrating certain special features affecting geodetic levelling, including the principal triangulation of Great Britain, the geographical position of the West European meridional arc, and of the European longitudinal arc. In the section of the pamphlet dealing with standard measurement it is interesting to observe that the national standard yard, which was legalised in 1855, consists of a marked length on a bronze bar bearing a definite relationship to the "international" metre (also a measured length on a bar), which was originally intended to represent one ten-millionth of the length of the earth's meridional quadrant.

Colonel Close's sketch of the various operations undertaken to determine the figure of the earth, dating from Airy's investigations of 1830 to Helmert's determination of 1906, proves incidentally the extraordinary value of the early investigations undertaken with inferior instruments. On Airy's figure the whole of the mapping of the United Kingdom still depends, nor have the results deduced from the reduction of the principal triangulation affected the map values. In the length of 700 miles from Shanklin to the extreme north of the Shetlands Airy's figure gives about four seconds in latitude too much, if we accept Helmert's figure as the criterion. This does not affect the linear accuracy of the map. Three figures were computed by Colonel Clarke (in 1858, 1866, and 1880 respectively) from the data furnished by the reduction of the principal triangulation. They are all in use, either in Africa or America. The mean value in length determined by Clarke of the semi-axis major of the ellipse, the revolution of which about its minor axis produces the spheroid of the earth's surface, is less than that of Airy and only slightly greater than that of Helmert. Colonel Close records his opinion that the probable value is somewhat greater than Clarke's mean.

Many people must have noticed the apparently haphazard way of recording "bench" marks by the Ordnance Survey to indicate altitudes determined by levelling. They are to be found on most unsubstantial walls, on milestones, and even on gateposts, and they must, many of them, inevitably be unstable. In the section of the pamphlet dealing with levelling, Colonel Close indicates the method by which, in future, such marks will be rendered permanent. Concrete blocks will be sunk on to hard rock foundations at intervals of about twenty-five miles all over the country; a bolt of bronze, with a knob of flint being embedded in the concrete. This section is also of interest as a record of the difficulties experienced in dealing with the adopted datum of mean sea-level. Indian survey investigations have contributed largely to the solution of this troublesome problem. It is in India, too, under Colonel Sir S. Burrard, that the most comprehensive investigations have been made in the matter of the deflection of the level, and the apparent eccentricities of the force of gravity, including the difficult problems which beset the speculative subject of isostasy; but Colonel Close's references to early English methods of determining the value of deflection due to local topography are extremely interesting as a record of the first steps taken in the evolution of this special branch of geodetic science. These plain and intelligible notes on a highly complicated subject, being entirely free from any affectation of technical specialism, should attract a much wider range of scientific interest than is indicated by the title of Ordnance Survey Professional Papers. T. H. HOLDICH.

SCIENTIFIC FACTORS OF INDUSTRIAL SUCCESS.

THE Institute of Industry and Commerce (now the Institute of Industry and Science), so the introductory leaflet states, is a counterpart of a German organisation known as the *Hansa Bund*. How the Hansa Bund arose or by whom and when it originated we have no knowledge. It is a confederation of important German firms for promoting, encouraging, and facilitating German home and foreign trade. It is proposed by similar means, but on somewhat "superior lines," to do the same for British industry, and the directors invite those interested in the development of our industries by the aid of science to enrol themselves as members. A portion of the revenue of each year is to be devoted to scientific research under the supervision of our most eminent men of science. Accompanying this leaflet are a number of brochures touching on the causes and effects of German commercial success and on the remedies for British commercial decline.

If "in the multitude of counsellors there is safety," in the diversity of their opinions there may also arise confusion. Sir W. Ramsay conceives that the main purpose of the Institute is to combat German industrial methods, which are said to be organised on a policy of dishonesty and trickery. This is to be undertaken by the State by adopting something of their methods, or by endeavouring to thwart them. Mr. S. Roy Illingworth, in his pamphet on "The Organisation

of the Chemical Industries," advocates combination between different branches of industry, elimination of home competition, efficient advertising, the employment of highly trained chemists and engineers, reducing the cost of production, and finally some measure of protection. Sir George Watson, who also writes on "Chemistry and Industry," lays stress on the importance of highly trained chemists and the value of protection or some form of financial assistance for the newer industries. Mr. J. Taylor Peddie, in his review of "British Imperialism and German Culture," points out that although German ideals have been established upon sound democratic and Christian principles, and have had a vital, sustaining, and elevating influence, these ideals have been momentarily wrecked on the rocks of feudalism, absolute monarchism, and militarism. He realises Germany's intellectual superiority, for which we have no substitute, and demands organisation unrestricted by the State, which is too much dominated by the political party system. In a second brochure on "Finance and Industry" the same writer finds Germany's great commercial progress to be primarily due to the development of its financial system, and instances the advantages which the banks offer by advancing loans to industrial undertakings.

It will be seen from this rather brief epitome that whilst the writers unite in pointing out the unsatisfactory position of our industries, especially those into which science largely enters, they are not quite unanimous, either in regard to the cause of or the remedy for the present state of affairs.

It is no doubt true that our chemical industries have in the past been hampered by absurd duties and still more absurd patent laws, and that, speaking generally, the scientific industries have received little sympathy or encouragement from any Government, past or present. It is also true that German commercial acumen, not always over scrupulous, has succeeded in wresting from us a good deal of foreign trade. In this connection we are reminded of a chapter in Bagot's "My Italian Year," in which he describes how Germans have established themselves, as well as their goods, in the larger Italian cities, and that much of the trade formerly carried on by us has passed into their hands. All this is true enough, but there is another side to the picture. Our chemical industries have failed to prosper not because Germany has had special advantages in the use of cheap alcohol, or in its patent laws, or in its financial system or in its protective tariff, but because in recent years these industries have passed into the hands of men who have had no proper chemical training.

So long as this exists the industry will be run by rule-of-thumb methods; no advance can be made, because nothing new is being discovered or manufactured; for it must be remembered that it is not the old stereotyped products, but the novelties that bring the large profits. Where can we show such a record as that of the Baden Aniline Company, which laid out a million sterling on experiments carried out by a body of highly trained and *highly paid* chemists working unceasingly for ten years in elaborating the process for producing artificial indigo, which has now nearly driven out the natural product?

We lack knowledge first and last, as well as enterprise and that kind of adaptability which studies to supply the needs of foreign countries, and this applies to others besides the chemical trade. We remember an old Lancashire cotton weaver, whose trade, once a thriving one, gradually fell away because he insisted on always producing the same kind of cloth long after it had ceased to be in demand, for no other reason than that he had always done so.

We could point to many other industries which to-day are languishing or disappearing for the same reason. The heads of these firms do not keep pace with the time; they do not keep up any pace at all; they stand still. They stagnate in a backwater of ignorance, unconscious of the rapidly flowing stream of scientific achievement; which must in the future be the guiding current in every branch of industry if commercial success is to be attained.

It was announced on Monday that there has been such a poor response on the part of subscribers that the directors of the company British Dyes (Limited) do not feel justified in proceeding to allotment, and a meeting has been called to consider the situation. This state of affairs might have been anticipated from the amount of adverse criticism to which the Government scheme has been subjected. The scheme restricted competition at home, but made no attempt to safeguard future competition from abroad, and gave no guarantee in the constitution of the directorate that the industry would be conducted on a sound scientific basis. The question is still unanswered as to the best and safest means of resuscitating this moribund industry (if one may apply these terms to describe what has never been really alive for the last half-century).

Every chemist will admit that this is a problem which cannot be solved in a hurry. Owing to the complex nature of the products and the special character of the apparatus and machinery employed, a long period of patient experimenting under the control of the best chemists and chemical engineers that the country can provide will be required before success can be attained. It will naturally entail a heavy outlay in salaries and plant, and probably no profits for a long time to come. Who is going to undertake this whilst the textile industry with its millions of workpeople is starved for the want of dyes? If the country ran short of ammunition in the present crisis, the Government would at any cost be compelled to undertake its production.

The same kind of national crisis exists to-day in the dyeing industry, and the same remedy should be applied without further delay. The colour-makers have had their opportunity. They have been warned for years past what their fate would ultimately be if they neglected to develop

their manufacture on a scientific basis. That opportunity has gone. The only practical plan would seem to be for the Government to take the matter in hand and independently of public financial assistance to obtain its staff of expert chemists under adequate scientific control, and by their aid to work out the initial experimental stages and afterwards either manufacture the dyes or make over the processes on certain conditions to private firms.

NOTES.

WE regret to see the announcement of the death, on March 21, in his sixty-fourth year, of Dr. A. A. W. Hubrecht, professor of embryology at the University of Utrecht.

THE honorary freedom of the Apothecaries' Company has been conferred upon Sir Ronald Ross, in recognition of the valuable services rendered by him to medical science, especially in the prevention of tropical disease.

IN recognition of their services as consulting surgeons to the British Expeditionary Force in France Mr. G. H. Makins and Sir Anthony A. Bowlby have been made Knights Commander of the Order of St. Michael and St. George (K.C.M.G.).

THE *Nieuwe Courant*, the Hague, of March 3, states that the van't Hoff fund committee of the Academy of Sciences of Amsterdam received five applications for grants. The only one awarded was for 600 francs to Dr. E. D. Tsakalotos, of Athens, in aid of his researches on the thermal properties, the viscosity, and the magnetic susceptibility of binary mixtures, capable of yielding endothermic compounds.

AT a meeting of the executive committee of the British Science Guild, held on March 16, it was resolved to send copies of a resolution formulated by the medical committee, advocating inoculation against typhoid fever, to the commanding officers of every regiment of the British Army. Reports on the question of the supply of optical glass and of glass for chemical purposes—formerly largely obtained from Germany and Austria—showing what has already been done in these matters, were also ordered to be widely circulated. The question of the shortage of microscopes was considered, and action is being taken by the guild in this matter.

THE death is announced, after a short illness, of Prof. W. Smart, professor of political economy at Glasgow University. Prof. Smart began his academic work in 1886 as lecturer on economics at University College, Dundee, and Queen Margaret College, Glasgow. On the affiliation of Queen Margaret College to the University, he became University lecturer on economics, and in 1896 was appointed to the Adam Smith chair of political economy. In addition to his professorial work, Prof. Smart translated Böhm-Bawerk's "Capital and Interest" and "Positive Theory of Capital," edited Wieser's "Natural Value," and compiled "Economic Annals of the Nineteenth Century." Among his other works are "Taxation of Land Values" and "The Return to Protection."

THE Geologists' Association has made arrangements for an excursion to Glasgow from April 2 to April 8. The object of the excursion is to examine the geology of the district around Glasgow. On April 2 Prof. J. W. Gregory will conduct the party around the Campsie Fells. On April 3 South Bute will be visited under the directorship of Mr. W. R. Smellie. Garabal Hill, Loch Long, and Loch Lomond will be studied on April 5 under the guidance of Mr. A. Scott; the Falls of Clyde, Cartland Gorge, and Kames of Carstairs on April 6, when Prof. J. W. Gregory and Mr. J. Stark will direct: Lugar and Mauchline on April 7, director, Mr. G. W. Tyrrell; Hamilton Park and Strathaven on April 8, directors, Messrs. Macintyre and Carruthers. Intending visitors should communicate with the secretary for the excursion, Miss G. M. Bauer, 16 Selborne Road, Handsworth Wood, Birmingham, from whom particulars as to trains and accommodation can be obtained.

THE death has occurred at Dartmouth, at the age of eighty-six, of Mr. E. W. H. Holdsworth, who will be remembered by his book, "Deep-Sea Fishing and Fishing Boats," published in 1874, which gives the best and most intelligent account of the British fisheries at that time which we possess. This book will always be of the first importance to those interested in the progress and development of our sea fisheries. Mr. Holdsworth wrote from great personal knowledge of the subject, as he had acted as secretary to the Royal Commission, of which Prof. Huxley was a member, which between 1863 and 1865 travelled all around the British coasts inquiring into the condition of the fisheries. At the close of the work of this Royal Commission, Mr. Holdsworth went for some years to Ceylon in order to conduct an official inquiry into the pearl fisheries. In 1883 Mr. Holdsworth took an active part in the International Fisheries Exhibition and contributed to the literature of that exhibition an important paper on apparatus for fishing. On the foundation of the Marine Biological Association he was for some years a member of the council. Previous to his work in connection with the fisheries Mr. Holdsworth took part in the management of the Zoological Gardens, Regent's Park, and the Proceedings of the Zoological Society contain several papers which he wrote, chiefly on anemones and corals.

MR. J. S. MACARTHUR, whose name is well known in connection with the cyanide process of extracting gold, has been engaged during the past two years in the extraction of radium from carnotite and similar ores at his factory at Runcorn. From a statement in the Press we learn that Dalvait, Loch Lomondside, has been selected as the site for a new factory, on account of the advantages offered by the purer air and water supply in this neighbourhood. The new factory is to deal with between five and six grams of radium annually, and will be a welcome addition to the country's sources of radio-active materials. Hitherto, with the exception of one concern, working up the pitchblende from the Trenwith mine, Cornwall, this country has been entirely dependent upon foreign radium. The output of another Cornish pitchblende mine is sent to France to be extracted, and the re-

cently discovered source of pitchblende of very fine quality in India, seems, like the Indian monazite, to be controlled by foreign capitalists. The Glasgow and West of Scotland Radium Committee purchased from Mr. MacArthur last year the equivalent of 600 milligrams of radium bromide in the form of a barium-radium carbonate containing 20 milligrams of radium bromide per kilogram, finding it more advantageous to undertake itself the further fractionation of this material than to purchase from abroad at the inflated prices then obtaining.

IN the scientific world probably the highest distinction is the election of a man of science to foreign membership of the leading scientific society of a country not his own. Prof. E. C. Pickering has from time to time published lists of men of science who have received this honour from two or more of the seven great scientific societies, viz., the Imperial Academy of Petrograd, the U.S. National Academy, the Royal Prussian Academy, the Royal Academy of Sciences in Vienna, the Royal Society, the Institute of France, and the Royal Academy of the Lincei. The first such list was published in 1908, and since then more than a third of the men whose names were included have died. Prof. Pickering, in an article in the February number of the *Popular Science Monthly*, has brought the list up to the beginning of 1914, and analysed it according to societies, countries, and sciences. The men of science whose names appear in the list number 122, sixteen of whom are members of all seven societies, and fourteen of six societies. Four men of science in Prussia, namely, A. Auwers (since deceased), E. Fischer, van't Hoff, and R. Koch, and three Englishmen, namely, Sir A. Geikie, Sir William Ramsay, and Lord Rayleigh, are members of all seven societies. Taking two groups together, England leads with eight men of science who have achieved the distinction of election to foreign membership of six or seven national scientific societies, and is followed by Prussia, which possesses six such men. The average number of scientific societies for English members is 4·9, for Prussian members 4·2, and for Germany as a whole, 4·0. As regards the different branches of science, "In mathematics, the country most largely represented is France, with 5 members; in astronomy, United States, 5, England, 4; in physics, England, 5; in biology, Prussia, 5. Great Britain is the only country represented in each of the sciences. Prussia has no geologist, France no geographer, and the United States no mathematician, chemist, botanist, or biologist."

THE jubilee of the University of Melbourne Medical School was celebrated on April 25–May 2, 1914, and a memorial volume containing the history of the school and the jubilee addresses, and embellished with numerous plates of the buildings and laboratories and members of the staff, has been issued ("University of Melbourne Medical School Jubilee, 1914," Ford and Son, Melbourne). The University of Melbourne had been in existence for seven years when its medical school was opened on March 3, 1862. The school owed its inception largely to the energy of Dr. Anthony Colling Brownless, who became Vice-Chancellor of the University in 1858. In 1862 Dr. John Macadam was appointed lecturer on chemistry, Dr. G. B. Halford professor of anatomy, and Mr. R. Eades lecturer in Materia Medica. In 1863, the medical school buildings were commenced from plans prepared by Messrs. Reed and Barnes, the University architects. In 1864, the Melbourne Hospital opened its doors to receive the first class of third-year students, Messrs. Rees, Moloney, and Mackie. Although its career has been checked from time to time by lack of funds, the story of the school is one of continued progress. Opening in 1862 with four students, the students' roll now (1914) numbers 394 for the five years of the curriculum. The latest development is the establishment of a fund for clinical research, which now amounts to approximately 1000*l.* per annum.

THE forty-eighth report of the Peabody Museum at Harvard University is a record of active progress. Additions to the buildings now provide much needed accommodation for the collections. Exploration has been active in various regions—Mexico, Nebraska, New Jersey, Arizona, Syria, Palestine, and Egypt. Dr. E. A. Hooton conducted an expedition to England. Landing in July last, he worked for a month, when "he was forced to discontinue work because of the unsettled state of the country." He excavated without much success the alleged site of an early Saxon cemetery at Great Shefford, Berks, and then he turned his attention to Wexcombe Down, overlooking Salisbury Plain, where nine barrows were opened containing incinerated remains, Bronze Age potsherds, and surface finds of late Celtic and Roman pottery. One large cinerary urn and one La Tène III. bronze fibula were found. From Knowle Pit, Savernake, a series of River-drift implements was obtained.

CAPTAIN SIR G. D. DUNBAR in the February '26 issue of the Journal of the Royal Society of Arts describes some of the tribes occupying the northern frontier of Assam. Owing to the inaccessibility of the country and the savagery of its inhabitants, little is known about them. The tribes here dealt with are the Abors, Daflas, and Mishmis. The word Abor means "unfriendly," which well describes the character of the group. The general type is Mongoloid, and the writer suggests that the Abors and their brethren migrated from the Tibetan side of the Himalayas into the Dihang valley. They display remarkable industrial capacity in their bridges, irrigation channels, and ironwork. It is not possible to imagine a more democratic organisation than the constitution of these tribes. The village, not the clan, is the political unit, ruled by a headman, whose office is not hereditary, but he is retained in office only so long as he represents the views of the majority in their rather noisy meetings. Women exercise a marked influence. Other duties now prevent Sir G. D. Dunbar from preparing a book on these tribes, but it may be hoped that this intention is only for a time postponed.

IN the *American Museum Journal* for February Col. Theodore Roosevelt contributes an admirable article on the animals of Central Brazil, and Mr. L. E. Miller gives an account of the Roosevelt-Rondon

Scientific Expedition. The value of this exploration will be shown only when full studies have been made of the 2500 and more specimens of birds and mammals which have been collected. This will for the first time provide an outline of the mammalogy and ornithology of this hitherto unknown region, which includes a river as long as the Rhine, of which there appears to be no trace on the existing maps. Of special interest is the account of the man-eating fish, the piranha. "South America," Col. Roosevelt remarks, "makes up for its lack relatively to Africa and India of large man-eating Carnivora by the extraordinary ferocity or blood-thirstiness of certain small creatures of which the kinsfolk elsewhere are harmless. It is only here that fish no bigger than trout kill swimmers, and bats the size of the ordinary flittermouse of the northern hemisphere drink the blood of big beasts and of man himself."

IN the Journal of the Straits Branch of the Royal Asiatic Society for December, 1914, Mr. J. C. Moulton, curator of the Sarawak Museum, continues his list of the butterflies of Borneo, dealing in this instance with the whites and swallow-tails, or Papilionidæ. No fewer than forty-three species, together with a number of subspecies of the true swallow-tails of the genus Papilio, are recognised, against twenty-nine in a list published by Dr. Russel Wallace in 1865.

TO the March number of the *Irish Naturalist* Dr. R. F. Scharff contributes a tentative list of the native names of Irish mammals. There is a considerable degree of uncertainty with regard to the proper application of some of these names, and in a few instances, which may represent species now extinct, identification has not yet been practicable. Several names for the bear and the wolf are known, and it is possible that one or more of the unidentified terms may refer to the extinct giant Irish deer or "elk."

A STRIKING coloured plate of the king-condor of the Andes forms the frontispiece to an article in the April number of *My Children's Magazine* on the vertical distribution of animal life on land and in the ocean. Most of the more striking instances of animals dwelling at great heights in the mountain-ranges of the world are mentioned, and the article as a whole is a mine of information. The artist cannot, however, be congratulated on his rendering of the red deer's antlers or on his so-called wild sheep and yak, which are obviously drawn from domesticated breeds.

IN Mr. T. Southwell's report of the Bengal, Bihar, and Orissa Fishery Department for the year ending June 30, 1914, attention is directed to the extent of the area under the control of the Department, the smallness of the staff, and the difficulties encountered, in endeavours to improve the present condition of affairs owing to the indifference and lack of energy on the part of the fishermen. It is admitted that in Bengal the supply of food-fish, always short, is steadily falling, but since the occupation of fishing or dealing in fish is carried on exclusively by the lower classes the whole industry is left in the hands of people with no capital, no education, and no business capacity. In such circumstances it is scarcely to be wondered at that the fish-supply is scanty. In area and potentiality the fresh-water fisheries of Bengal are second to none; but the establishment of hatcheries for carp and other species of fish is highly desirable in order to mitigate the disaster to eggs and fry occurring annually in the big rivers during the rains. The rearing of eggs and fry removed from the mouth of the Damodar and their return to the river as young fish at an age when they are able to look after themselves, seems to be a step in the right direction, and one which should eventually give satisfactory results. As time and opportunity allow, the stocking of other small rivers will be carried on, where the necessity is indicated. The rearing of fry in special tanks will further enable small fish to be supplied for tank-culture throughout the province, at an age when they are unlikely to be devoured by voracious fish, whereby considerable improvement in tank-culture generally may be expected.

AMONG specimens received by the U.S. Museum from the Lower Eocene of Fort Union, Montana, particular interest attaches to the left half of the lower jaw of a small mammal described by Dr. J. W. Gidley in No. 2077 of the Proc. U.S. Nat. Mus. (vol. xlviii., pp. 395–402) as a new genus and species under the name of *Myrmecoboides montanensis*. The specimen, which retains the canine and seven cheek-teeth, is regarded by its describer as indicating a marsupial, which may be related to the Australian banded anteater (*Myrmecobius fasciatus*). The dentition presents the distinctly marsupial feature that all the last four cheek-teeth are molariform, and of the same general type, the first of the series being, however, slightly more complex than the other three. In many respects all the teeth present resemblances to those of Myrmecobius, although those with a molariform structure are relatively larger, and not separated from one another by intervals. If, however, the dentition of Myrmecobius be of a degenerate type, as is now generally believed, such differences are precisely those which would be expected in an ancestral form. What an important bearing such a relationship would have on the origin and dispersal of marsupials will be obvious. In addition to this, the Fort Union fossil may serve to solve a disputed point in regard to marsupial dentition. For, as Dr. Gidley points out, the first molariform tooth presents several features suggestive of its being a persistent milk-molar rather than a molar; and if this idea be well founded, there will be decisive evidence in favour of the view first suggested by Dr. Winge, and also arrived at independently by Mr. Lydekker in 1899, that the first molariform tooth of marsupials is a persistent milk-molar, and not, as previously supposed, a molar, and consequently that both placentals and marsupials normally possess but three pairs of molars.

WE note with interest that the Lincolnshire Naturalists' Union is taking steps to preserve the ancient flora of Lincolnshire from extinction. Owing to cultivation, drainage of bogs, eating off by sheep, and the rapacity of trippers much has been lost. By educating the populace to respect the flora and by

jealously guarding the habitats of the rarer plants, the Naturalists' Union should do useful work.

THE *Indian Forester* for January, vol. xli., No. 1, contains a short account of the tali-pot palm (*Corypha umbraculifera*), which is indigenous in the Andamans and Southern India. Its uses are many; the pith is used for flour, some thirty headloads being yielded by one tree. The leaves, which were formerly used for writing upon, now serve for umbrellas and thatching, and the seeds are carved or made into buttons. At Honawar bats live under the protection of the leaves of the tali. When the lendi fruit (*Calophyllum inophyllum*) is ripe, the bats bring back large quantities to their palm and drop the hard drupes. As these contain oil, which is much prized, the bats serve a useful purpose, and natives are planting the tali-pot palm in order to obtain oil in this easy manner.

IN an article reprinted from the *Botanical Gazette*, vol. lviii., No. 3, Dr. G. D. Fuller breaks new ground in plant ecology and presents results which, as in the case of much recent work in this subject, is of great interest to agriculturists and foresters as well as to botanists. He has made a detailed series of determinations at weekly intervals during the growing period (May to October) of the rate of evaporation and the amount of soil moisture in a series of plant communities which shows a gradual change or succession from exposed sand vegetation to moist beech-maple forest on the sand dunes near Chicago. The determinations, extending over three years, are presented in graphs; those of evaporation were taken with evaporimeters placed near the ground, those of soil moisture in the upper layers of the soil—in both cases the critical regions, since within them develop the seedlings which determine the character of the succeeding vegetation. The author introduces the term "growth-water" for the percentage of soil moisture in excess of that found by experiment to be present in the soil when wilting occurs in plants; and he finds that the differences in the ratio between evaporation and growth-water in the series of plant communities investigated are sufficient to be regarded as efficient factors in bringing about the succession or gradual change from the scanty drought-enduring (xerophytic) vegetation of the open sand to the moisture-loving (mesophytic) broad-leaved forest, which forms the climax of the series.

IN vol. xiv., part 1, of the Annals of the South African Museum Mr. George Arnold, of the Rhodesia Museum, Bulawayo, commences an illustrated monograph of the ants of South Africa, which it is claimed will form the first collective account of the (approximately) three hundred known local species. Vol. xv., part 1, of the same is devoted to a continuation (part 7) of the Rev. T. R. R. Stebbing's account of South African Crustacea. Six species and two genera of Macrura are named as new, and certain emendations in pre-existing nomenclature suggested.

THE association of geology, botany, and zoology in the domain of a State Survey is interestingly exemplified in the sixth biennial report of the Commissioners of the State Geological and Natural History Survey of Connecticut. The superintendent, Prof. W. N. Rice, points out the desirability of the maintenance of the survey as a permanent bureau of publication. Much of the work is done by men who are otherwise engaged for a large part of the year, and the annual appropriation of 1500 dollars may be considered modest for a State where a high level of general culture is ready to respond to scientific information.

THE potash salts associated with the Cambrian rock-salt of the Cis-Indus Salt Range have been known since 1873; but a more complete examination of their extent has now been made by Dr. W. A. K. Christie (Records Geol. Survey of India, vol. xliv., 1914, p. 241). This author concludes, on account of the association of kieserite, sylvine, langbeinite, and rock-salt, that crystallisation finally took place under subterranean conditions at a temperature of about 80° C. It is interesting to note that the very soluble potash-salts have been preserved where a fine clay with sand-grains, probably wind-borne, was formed across the deposits of the evaporating lagoon.

AN interesting rock is described by Dr. du Toit from the slope of Ingeli, in the extreme south-west of Natal (Geological Survey of South Africa, Annual Report for 1913, p. 99). In a stratum about 15 ft. thick, pellets of graphite, which may be as much as an inch in length, lie in a ground of oligoclase, quartz, cordierite, enstatite, and biotite; this ground has in part a micropegmatitic structure. This unique rock is ascribed to the partial absorption of a carbonaceous shale of the Ecca Series by an offshoot from the overlying intrusive sheet of norite. Kentallenite, the curious biotite-olivine-dolerite with soda-orthoclase, well known from its occurrence in Appin, is now recorded by Mr. S. Kôzu from Torigoé, Japan (Science Rep., Tôhoku University, Sendai, Japan, vol. ii., 1914, p. 1).

THE South Wales tornado of October 27, 1913, which involved some loss of life, has been discussed by the Meteorological Office in No. 11 of its Geophysical Memoirs (price 6*d*.). Dr. Shaw states that a scientific assistant attached to the office, Mr. H. Billett, was sent to the neighbourhood to collect information on the spot. A severe thunderstorm swept the west of England and Wales from the south of Devon to Cheshire, and developed locally into a tornado of exceptional violence. The storm was intense for a distance of about 11 miles up the Taff Valley in Glamorganshire, for about an equal distance in Shropshire, and for about 5 miles in Cheshire. For several days before and after the occurrence, a high-pressure system was situated over Central Europe, and there was a low barometer centred over the Atlantic. The wind over the region affected was mainly from south-east or south, with the temperature decidedly above the average, and the weather unsettled. The rainfall was almost wholly limited to the south-western and western districts of England. Practically no damage was done outside the narrow limits of the storm, which nowhere exceeded 1000 ft. in width, but much destruction was wrought in certain parts of the track. In Cheshire, where the storm's track was about 450 ft. wide, the sound is described as that

of "hundreds of motor-cars crashing through the trees." The storm occurred at about 4 p.m. in Devon, at 5.40 to 5.50 p.m. in South Wales, at 7.35 to 7.45 p.m. in Shropshire, and at 9 p.m. in Cheshire. The progress of the central area of the storm is given as 36 miles an hour No absolute measurement of wind velocity was secured, and a similar absence of barometer records is mentioned, with the exception of one station only a few yards from the South Wales track, where the record shows a fall of pressure from 29·20 in. to 28·91 in., followed by an almost immediate rise.

THE *Scientific American* for February 13 contains the third of the series of articles entitled "Doing without Europe," to which we referred in these columns a month ago. The principal object of the articles is to show how vast are the mineral resources of the country and how little they are utilised. The present article deals mainly with the barium salts used in the manufacture of paint. Up to the commencement of the present war these had been imported from Germany, but one of the largest paint manufacturers of New York has commenced manufacturing them from an ore found in Tennessee, and now turns out 15 tons a day. In respect to potash salts, of which the annual import from Germany exceeded 3,000,000*l.*, the United States Government has directed attention to the natural deposit of the salts at Searles Lake, California, and a manufacturing plant has been set up there the success or failure of which will be watched with interest. Soda, magnesia, and several other substances are also mentioned as being found in abundance in the country, and as only requiring working to supply all requirements.

AN interesting paper on the internal-combustion engine in the oil field was read at the Institution of Petroleum Technologists on March 18 by Mr. F. G. Rappoport. It appears that the steam engine still largely holds its own despite its inefficiency, the reason for this being in the special character of the work to be done in boring and baling oil wells. Great flexibility in power and speed is required, and while electric power distributed from central stations is ideal from other points of view, electricity lacks that flexibility at the well which makes steam power so convenient. The oil engine has created a large and important sphere of its own by facilitating profitable operation of a large class of wells having a small yield. Such wells had formerly to be closed, and the advent of the oil engine with its low fuel-consumption has rendered possible their operation. The oil engine is well adapted for outlying districts and for prospecting work; the Binagadi oil field, without adequate water supply, is worked almost entirely by means of oil engines. The new Ural and Biellik districts in Russia are largely worked by oil engines. Applications of the gas engine are also discussed, and reference is made to an engine made by Messrs. Tangye, which can be run as a gas engine, or as an oil engine, by alteration of certain parts. Several of these engines are in successful operation on the Baku oil field.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have just issued a classified catalogue of numerous scientific books, periodicals, and publications of scientific societies which they offer for sale, including large selections from the libraries of the late Sir Robert Ball and Dr. J. Reynolds Green. The catalogue contains titles and descriptions of many rare and valuable works which may be purchased at reasonable prices for private or public libraries.

OUR ASTRONOMICAL COLUMN.

COMET NOTES.—In the *Astronomische Nachrichten* (No. 4789) Dr. Elis Strömgren communicates an ephemeris up to March 29 for comet Mellish (1915*a*), computed by Herren J. Braae and J. Fisher-Petersen, from the parabolic elements given by the latter, with Herr R. Andersen. The data for the present week are as follows:—

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
March 25 ...	17 55 53 ...	−0 34·9 ...	8·8
27 ...	17 58 13 ...	0 50·0	
29 ...	18 0 33 ...	1 6·1 ...	8·6
31 ...	18 2 51 ...	1 23·1	
April 2 ...	18 5 9 ...	−1 41·2 ...	8·5

The comet lies approximately between γ Ophiuchi and η Serpentis.

Herr K. Hillebrand, in an Ephemeris Circular of the *Astronomische Nachrichten* (No. 478), publishes the elements and ephemeris of the periodic comet of Winnecke for its appearance in the current year. The latter extends from April 16 to the end of August.

A search ephemeris for Tempel's comet (Ephemeris Circular, No. 479) is given by Herr J. Braae. In 1910 this comet was not seen, but it is pointed out that this year it will be a little more favourable for observation. The ephemeris is extended to the end of June of the present year, and will be continued later.

THE STRUCTURE OF THE Hγ LINE IN STELLAR SPECTRA.—In this column for July 31 of last year attention was directed to a paper by Herr K. F. Bottlinger, in which was shown the result of a study of the intensity distribution of lines in many of the brighter stars. In a recent number of the *Astronomische Nachrichten* (No. 4788, vol. cc., No. 12) Dr. Adolf Hnatek gives his conclusions from rather a similar investigation. The author has measured both the intensity (Linientiefe) and breadth (Linienbreite) of the Hγ line in several bright stars, and summarises the values deduced according to the spectral types of the stars examined. Thus, in the case of the line-width the following are mean values in Ångström units which he has deduced.

Maury	Cannon	Width	Intensity
II–VI ...	B ...	16 ..	0·55
VII–VIII ...	A ...	26 ...	1·40
X–XI ...	F ...	17 ...	0·81
XIII–XV ...	G–K ...	8 ..	0·35

Summarising the values of the line-intensity (Linientiefe), he points out that they show also a similar relation to the spectral types; these intensity values are added in the last column of the above table. The paper contains also a number of curves of the Hγ lines in the individual stars arranged in groups according to their spectral classes. While the above investigation deals only with one line and a small number of stars, the author hopes to extend the research to more lines and stars in order to deduce results of a more definite and trustworthy value.

THE HARVARD COLLEGE OBSERVATORY REPORT.—The annual report of the director of the Astronomical Observatory of Harvard College for the year ending September 30, 1914, indicates the completion of a large amount of work in both observation and publication. Prof. E. C. Pickering refers in the first place to the principal work of the observatory, namely, its publications and the importance of issuing these as soon as possible to prevent loss by fire. Thus observations from 1892–1912 with the 15-in. equatorial, from 1888–98 with the 8-in. transit circle, and from 1898–1912 with the 12-in. meridian photometer are now printed, and the discussions are in progress. The director directs attention to the improvement in photographic processes resulting in the replacement of practically all visual work. The report then describes in more detail the work of the Henry Draper Memorial, the principal research of which is the New Draper Catalogue; last year Miss Cannon classified 60,386 spectra, making a total of 160,541. The activities of the Boyden department, the Bruce photographic telescope, and the Blue Hill Meteorology Observatory are briefly summarised, while among the many items mentioned under the heading "Miscellaneous" the work of Prof. W. H. Pickering at the Mandeville Station, in Jamaica, is described, much time having been devoted to the study of the planet Mars during its recent opposition.

STAR CHARTS FOR METEOR OBSERVERS.—One of the contributions to the January number of the Journal of the Royal Astronomical Society of Canada (vol. ix., No. 1, p. 7) is entitled "A Gnomonic Star Atlas," and contains a set of thirteen maps, prepared by Mr. Reynold K. Young, intended to facilitate the observation of meteors and the plotting of their paths. The method of the projection of the map is such that great circles in the sky are equivalent to straight lines on the map, thus making the plotting of the meteor trails more easy. The maps are devoid of unnecessary detail. The positions of the stars are given for the epoch 1900 correct to within one-tenth of a degree, and all stars down to 5th magnitude and the brighter variables are included. A good margin of overlap has been allowed in each map, which should prove very useful.

FLUCTUATIONS OF TEMPERATURE IN EUROPE AND AMERICA.

MR. H. ARCTOWSKI, in a paper published in vol. xxiv. of the Annals of the New York Academy of Sciences, considers the problem of variation of temperature over the whole earth. After a brief statement of the general problem and the methods by which it may be attacked, he explains that he could not deal single-handed with the arrangement and discussion of the actual values even over the whole of the northern hemisphere, and confines himself to the detailed survey of the variations over North America and Europe. He also compares the results with one or two representative equatorial and southern hemisphere stations. From a study of the values at one of these, Arequipa, in Peru, he deduces that the temperature changes are partly of a short period of about fifty-five days, brachypleionian waves; partly of a long period of twenty years or so, macropleionian waves; and partly of an intermediate period of between one and two years, pleionian waves.

In dealing with the longer periods the normal annual variation is eliminated by taking a series of means for twelve months beginning with each consecutive month of time. For the European stations he finds that the continental ones resemble Arequipa in having marked pleionian waves, while those stations near the Atlantic are characterised mainly by brachypleionian variations.

In an earlier paper Mr. Arctowski dealt with the period 1891–1900, and he takes the mean values for this period as normals, and plots on maps the difference from normal of the values during each year of the decade 1900–09. The areas where the differences are positive he calls thermopleions, and the areas of negative differences antipleions. He finds that certain years, in particular 1900, 1908, are characterised by thermopleionian areas, while others, such as 1904, 1907, are years of antipleions. The most important cause of these differences is the variation of solar radiation, but there are also supplementary causes such as the presence of volcanic dust in large quantities, or exceptional ice conditions in the polar regions.

Many of the maps which illustrate the results of the investigation are on a very small scale; the course of the thermopleions and thermomeions is obscured by the attempt to show relatively microscopical geographical details.

Mr. Arctowski finds it astonishing that after all the efforts which are made to organise and maintain meteorological stations all over the world, the actual results of the work are so inaccessible. Even for the area with which he dealt he could only get much of the data by writing personally to the directors of the different meteorological institutes. This is a defect which will be remedied when meteorologists of different countries undertake to contribute to a central bureau representative regional values based on a selection of stations which can only be chosen satisfactorily by the local organisation.

There is another defect which is almost more serious, viz., the lack of continuity in the records for individual stations due to changes of situation or instruments. For example, Mr. Arctowski finds that the difference of temperature between Chicago and Milwaukee was nearly 4° F. in the decade 1873–82, while in the decade 1896–1909 the difference was only 2° F. The change is almost certainly due to change of instrument or site, and as it is of the same order of magnitude as the changes with which he deals, it indicates the need for great caution.

The difficulty of securing comparable continuous records is indeed one of the most serious problems with which organised meteorology has to deal.

E. G.

REFINING GOLD BY ELECTROLYSIS.[1]

THE problem presented by the necessity of refining gold was one for which a solution was sought at least as early as the time, about B.C. 700, when coins were first manufactured in the Western world. Apart from toughening or the removal of base metals, which was sufficiently cared for by the ancient process of cupellation, it is clear that some measure of success attended the efforts made to part gold and silver. Thus, some of the ancient Greek coins containing 997 or 998 per 1000 of gold. The earliest parting process used was one of cementation, which was succeeded by the nitric acid process. At the present day chlorine is the predominant agent for parting gold from silver in Australia, electrolysis in America, and sulphuric acid in Europe.

The electrolytic process was brought forward by Charles Watt, at Sydney, in 1863, and was first put into operation by Wohlwill at Hamburg in 1878 and by Tuttle at the Philadelphia Mint in 1902. In the gold chloride process the solution used in the bath

[1] Abstract of the presidential address delivered before the Institution of Mining and Metallurgy on March 18, by Sir T. K. Rose.

contains gold in the form of chloride and some free hydrochloric acid. Gold is dissolved at the anode, under the action of a current of electricity, and deposited in a pure state at the kathode. Other metals are also converted into chlorides at the anode, and either remain in solution, or pass into the anode slime. When silver is contained in the anode, it is converted into silver chloride which in part dissolves, in part falls to the bottom of the cell, and in part adheres to the anode, forming an insoluble coating. The result of the coating is that the free area of the anode is reduced, the density of the current becomes greater per unit area of effective anode surface, and chlorine is evolved unless a very small current is used. According to general experience, if more than 6 per cent. of silver is present in the bullion of the anode it is necessary to brush the silver chloride from the anodes, and accordingly this percentage is seldom exceeded in practice.

Photo] FIG. 1.—Electrolytic gold cells, United States Assay Office, New York. [*B. P. Wirth.*

The usual amount of free hydrochloric acid present in the bath varies from 3 to 10 per cent., but according to the results of experiments now put forward by Sir Thomas Rose some advantages are obtained by the use of stronger solutions. Thus in a bath containing 29 per cent. of free hydrochloric acid, a current of 5000 amperes per square metre of anode surface can be used without causing chlorine to be evolved at the anode. Under these conditions the proportion of silver in the anode may be raised to at least 20 per cent. without difficulties being encountered. The heavy current causes the silver chloride to split off from the anode, and also prevents gold from entering the anode slime, principally because no monochloride of gold is allowed to form.

Similar advantages occur in the deposition of gold at the kathode by the use of a solution containing 20 per cent. of gold as chloride instead of the usual 3 to 5 per cent. With a current of 5000 amperes per square metre, the gold is deposited in a coherent form, which is easily washed, and is malleable after being melted. The density of current now employed in practice is below 1000 amperes per square metre, and the anodes occupy about a week in being dissolved. With a current of 5000 amperes, the anodes would be dissolved within the limits of a working day and a saving in interest, and in the difficulties of daily stock-taking, would be effected.

One of the merits of the electrolytic process is that the refined gold is always malleable and fit for use in the arts, and another is that any platinum contained in the gold is extracted. This is becoming of some importance in view of the high price of platinum and of the fact that nearly all rough gold bullion, including that from the Transvaal, is now known to contain that metal. According to the experience in the United States mints (Fig. 1), it is cheaper to refine gold by electrolysis than by sulphuric acid.

BIRD-MIGRATION IN 1913.[1]

WE have before us the ninth of a projected series of ten reports setting forth the imposing mass of data regarding bird-migration collected by the committee appointed for the purpose by the British Ornithologists' Club. Once the final volume, dealing with the autumn of 1913 and the spring of 1914, has appeared, we may expect a publication of greater importance, summarising the vast amount of material collected by ten years' labour. In the meantime no attempt is made to draw conclusions from the facts which are published, but a few points about the movements of 1912–13 may here be selected for notice.

The autumn of 1912 appears to have been remarkable for the early dates at which the migrations of several species began. Thus a swallow was noted at the Bell Rock Light in the Firth of Tay on July 4, and willow-warblers at the same place two days later. As early as June 25 a large flock of starlings had been seen flying west in the evening at Spurn Head Light. On the nights of July 14–15 and 15–16 swifts were recorded from the Lundy North Light (British Channel) and the Hanois Light (Channel Islands) respectively.

The great movements, however, do not seem to have begun until mid-October, and the migrations observed during the first three weeks of November were of extraordinary magnitude. Almost every night during that period half-a-dozen different light-stations record the passage of large numbers of birds, notably skylarks, starlings, and various species of Turdus.

[1] Report on the Immigrations of Summer Residents in the Spring of 1913; also Notes on the Migratory Movements and Records received from Light-houses and Light-vessels during the Autumn of 1912. (Bulletin of the British Ornithologists' Club, vol. xxxiv., December, 1914.)

The winter which followed was marked by comparatively high and uniform temperatures. Consequently many summer-visitant birds do not seem to have quitted some of the southern and western districts, while others were recorded as returning at unusually early dates. The spring immigration proper is stated to have lasted from March 6 until June 6, reaching its height between April 14 and May 11.

Attention is directed to the very long period covered by the immigrations of certain species as contrasted with those of others. On one hand we have swallow (March 8 to May 20), sand-martin (March 13 to May 15), chiff-chaff (March 6 to May 8), and wheatear (March 12 to May 12). On the other we have the reed-warbler (April 18 to May 5), wood-warbler (April 9 to May 11), and nightingale (April 13 to May 5).

A special feature of the report is the long list of records emanating from the Caskets Light in the Channel Islands. This station is exceptionally favourably situated, and was expected to furnish very important data. Unhappily, the committee had formerly been unable to induce the light-keepers to take the matter up. The desired result has been brought about, however, by the transfer to the Caskets of an enthusiast in the work, Mr. R. E. Wilson. His contributions to the present report are very valuable. A special summary of the records relating to this station is promised for the next report.

The publication under discussion is even bulkier than its recent predecessors, but the data are set out in the same clear and orderly manner. As usual there are numerous charts and a useful summary of the meteorological conditions prevailing during the period covered by the migration records A. L. T.

THE INSTITUTE OF METALS.

IN spite of the war, both the number and quality of the papers presented at the annual meeting of the institute on March 18 and 19 were well up to the average. Naturally, in the circumstances, the contributions were furnished mainly by what may be termed the "academic" workers in non-ferrous metallurgy. Moreover, although the attendance of members was small, the discussions were always interesting and well-sustained. Unfortunately the president of the institute, Engineer Vice-Admiral Sir Henry Oram was prevented by his onerous official duties at Whitehall from presiding at the proceedings, and his place was filled at the last moment by one of the vice-presidents.

The paper by Prof. A. C. Huntington, on the effects of heat and of work on the mechanical properties of metals, gave rise to an interesting debate, and a spirited reply by the author. It describes a machine devised by him several years ago for the purpose of investigating these effects while the metals are being subjected to alternating bending stresses, such as occur in the fire-box of a locomotive. No attempt was made to reproduce the somewhat complicated movements which occur there, but the metal or alloy was held rigidly at one end, and "subjected to a to and fro movement at the other end in a single plane at right angles to its axis." Both as regards the extent of the movement and the range of temperature investigated, the experiments were made to conform broadly to the kind of conditions that obtain in locomotive fireboxes. Various kinds of commercial copper, and a copper alloy containing upwards of 5 per cent. of nickel and iron, were tested in this way. The outstanding feature of the curves, the co-ordinates of which are temperature and the number of revolutions required to crack and break the specimens, is the large number of maxima and minima which the author interprets from his data. For copper he gives five maxima and five minima. The fact, however, that these do not by any means always correspond to observed points gave rise to considerable criticism in the discussion and to a variety of alternative interpretations. From the fact that annealing greatly reduces the maxima and minima the author concludes that work plays an important part in emphasising transformation points, and goes so far as to say that "except in the case of phase changes in alloys, mechanical tests are to be preferred to heating and cooling curves as a means of studying changes of state with temperature." Even if this claim is admitted, it limits the application of such methods to ductile alloys, but not unnaturally objections were voiced to a statement which has certainly not been proved.

Dr. Rosenhain, in his paper, entitled "Some Appliances for Metallographic Research," described an optical instrument for the levelling of metallographic specimens, a new method of taking thermal curves, and a plotting chronograph, the last-named having been devised with the help of the Cambridge Scientific Instrument Co. These appliances have been originated by Dr. Rosenhain at the National Physical Laboratory. Great interest was expressed in them, particularly in the design of furnace for taking thermal curves. In order to obtain as nearly as possible a constant rate of heating or cooling of the metallic specimen a tubular furnace is erected vertically in which a "regular temperature gradient is established and steadily maintained while the specimens whose heating and cooling curves are to be taken are moved at any desired rate from the cold to the hot end of the furnace or *vice versa*." Heating and cooling curves obtained in such a furnace and in conjunction with the plotting chronograph show that very satisfactory results have been obtained. The power consumption with the hot end at 1000° C. is a kilowatt. No figures for higher temperatures have been given, and it will be interesting to have those stated when they have been determined.

With regard to the plotting chronograph, the author's endeavour has been to originate an instrument which shall furnish an inverse rate curve "plotted to an adequately open scale." The apparatus is not as yet entirely self-recording, but represents a considerable step in this direction, and it gives the curve obtained with no other human intervention than the periodic tapping of a key.

The paper by Prof. Read and Mr. Greaves, of University College, Cardiff, contains an account of their investigations on nickel-aluminium and nickel-copper-aluminium alloys, more particularly the light alloys of the last-named group, and is a continuation of their earlier work on the heavy alloys of the same metals. They find that, as regards the ternary alloys, copper and nickel can replace each other without the resulting properties being affected, and, in fact, that certain characteristics of the alloys are determined by the total percentage of copper and nickel present. As they point out, this is intelligible in view of the fact that the two metals possess almost identical densities and very similar atomic volumes. Moreover, micrographic analysis shows that the internal structure of the alloy scarcely alters when the one metal replaces the other. Inasmuch as nickel costs about three times as much as copper, and its melting point is nearly 400° C. higher, it is clear that it cannot compete with it economically in the case of such alloys, except perhaps in a few instances where the need for resistance to corrosion in certain liquids is sufficiently imperative to outweigh considerations of expense.

A very useful compilation of etching reagents and their applications to metallography was presented by

Mr. O. F. Hudson. This work had been undertaken at the request of the Publication Committee of the institute, and in preparing it Mr. Hudson received and incorporated methods adopted by well-known workers both in America and this country. The paper deals more especially with the final stage in the preparing of specimens for microscopic examination, but as the author points out, the effects of previous operations must always be borne in mind. There is now an increasing consensus of opinion among the most skilled metallographers that grinding on mechanically-driven discs produces too severe an alteration in the surface structure of a metal or alloy, which is likely to create difficulties in their microscopic interpretation after etching, and that hand grinding, although slower, is much more trustworthy. This is neither more nor less than a return to the technique of the late M. Osmond, whose skill in the preparation of a specimen for microscopic examination has never been surpassed. The discussion on Mr. Hudson's paper was in a high degree illuminating, and showed the institute members at their best. When the complete paper and discussion are published they will certainly be a standard work of reference.

Four other papers were submitted. Of these, that by Mr. Whyte, on the microchemistry of corrosion, and that by Mr. Haughton, on the constitution of the alloys of copper with tin, were read and discussed. The remaining two were taken as read, and will be discussed by written communications.

H. C. H. CARPENTER.

SUPPLIES OF LABORATORY AND OPTICAL GLASS APPARATUS.

REPORTS OF THE BRITISH SCIENCE GUILD.

THE British Science Guild has just issued two reports dealing with matters of national moment at the present time. One is concerned with the provision of glass apparatus for educational purposes, and the other with optical glass and the position of technical optics generally in this country. The reports are here reprinted, and it will be seen that they are both informative and helpful. First, with regard to laboratory ware, it appears that, as the result of an inquiry instituted by committees of the guild, working in co-operation with the Association of Public School Science Masters, about three-quarters of the schools or other bodies requiring laboratory glassware have undertaken to use British glass during the war, and for a period of three years after, provided that the price is not prohibitive. As explained in a letter to NATURE of February 18 (p. 670) the British Laboratory Ware Association has made arrangements for the supply of laboratory glassware and similar materials from British manufacturers. The British Science Guild has, by its action, presented the association and British glass manufacturers generally with an assurance of support which should be of the greatest value to them.

The report of the Technical Optics Committee of the guild should cause serious attention to be given to the establishment of a British Institute of Technical Optics. In the last annual report of the guild it was pointed out that this necessity had been impressed upon the education department of the London County Council continuously during the past twelve years. Scientific experts, leading members of the optical industry, and educational experts have combined to urge the paramount importance of the definite proposals which have been formulated, but the scheme still hangs fire. Meanwhile our scientific and industrial rivals on the Continent, taking note of successful developments on a small scale which have been originated here, have gone forward to new developments with increased vigour and with highly successful results.

(1) PROVISION OF GLASS APPARATUS FOR EDUCATIONAL PURPOSES.

In the past practically all the glass and procelain apparatus used in chemical laboratories in this country has been manufactured in Germany and Austria. As the supply is now cut off and the stocks held by British dealers are almost exhausted, the problem of obtaining apparatus for educational and technical purposes has become a serious one.

The Joint Committee is informed that efforts are now being made by several firms to introduce the manufacture of glass apparatus into this country, and being in hearty sympathy with these efforts, it has considered in what way the British Science Guild may best assist. In these efforts the committee has co-operated with the Association of Public School Science Masters, and has taken action along two main lines, viz. :—

(A) Endeavouring to obtain assurances of support for British makers of educational glass ware after the war as well as now.

(B) Obtaining information from educational institutions respecting the principal types and sizes of glass apparatus in greatest demand.

(A) *Assurances of Support for British Makers of Scientific Glass Ware.*

It is understood that the efforts during the last three months by certain British glass manufacturers have been attended with satisfactory results as regards the quality of the products. Economic and manufacturing conditions have prevented British glass apparatus being sold at so low a price as has been paid in the past for German material. As these conditions will probably remain unchanged, British manufacturers have been naturally disinclined to expend the necessary capital in establishing the proposed new industry here while there is every likelihood that they will be undersold in the British market by their competitors when the war is over. The Joint Committee is informed that this has acted as a strong deterrent to British glass manufacturers contemplating the production of scientific glass apparatus.

The Joint Committee therefore has endeavoured to ascertain how far it is probable that educational institutions would undertake to buy only British-made glass and porcelain apparatus during the war, and for a period of three years after.

Inquiries were made in this direction by the hon. secretary of the Association of Public School Science Masters, who is a member of the Joint Committee, from the headmasters of all schools represented on the Headmasters' Conference. Out of the hundred and ten (110) schools so represented, no fewer than seventy-eight (78), *i.e.*, 71 per cent., have definitely promised to authorise their science staffs to purchase, as far as possible, only British-made glass apparatus during and for a period of three years after the conclusion of the war. As these promises have been received from almost all the largest schools, both boarding and day, it may be assumed that manufacturers as well as dealers will receive adequate support from the "conference schools."

The guild also issued about 750 letters of inquiry to—

(*a*) Local education authorities.
(*b*) Governors of secondary schools.
(*c*) Governing bodies of technical institutions.
(*d*) Senates of universities and university colleges,

and has received a very large number of replies.

The proportion of definite replies coming in at once has been smaller than in the case of the public schools from the fact that various committees have had to be consulted before definite promises could be given, but the replies which have been received have been quite satisfactory—of the definite replies received about 72 per cent. are sympathetic, and promises are given to purchase only British-made apparatus as requested, subject in many cases to the proviso that the increased cost is not prohibitive.

A considerable number of the replies, while generally sympathetic, give no guarantee, the reason being in most cases that the matter rests with a higher authority, such as a county council, or board of governors, from whom no definite reply had been obtained. Some authorities, also, while sympathetic, do not feel able to bind their successors, and one authority suggests that only the purchase of German and Austrian apparatus should be barred.

The endeavour to obtain the value of the apparatus used in such institutions has not resulted in any very precise information, but from the facts before the committee it is clear that the value of such apparatus must at least run to some thousands of pounds.

(B) *Types and Sizes of Apparatus most in Demand.*

Inquiries as to the principal types and sizes of apparatus most generally used have been made on behalf of the Joint Committee from public schools and technical schools. It was felt by the Joint Committee that this information would be of considerable value to glass-makers, as there is a very strong feeling among those concerned with the chemical apparatus trade that at the present time flasks, beakers, basins, etc., are supplied in an unnecessarily large variety of shapes and sizes.

Judging from the replies received from the institutions above referred to, the following represent the apparatus most in demand:—

TEST TUBES.—6 in. × ¾ in., 2 in. × ½ in., and, in smaller quantities, 6 in. × 1 in., 5 in. × ⅝ in., and 2 in. × ⅓ in.

BEAKERS.—Squat form, lipped, 200 c.c., 300 c.c., and, in smaller quantities, 150 c.c., 500 c.c., 1000 c.c.

BEAKERS.—High form, in the same sizes as above, but in smaller quantities.

FLASKS.—Flat bottom, 100 c.c., 250 c.c., 500 c.c., and, in smaller quantities, 1000 c.c., 1500 c.c., 2000 c.c.

FLASKS.—Round bottom, 250 c.c., 500 c.c.

TUBULATED RETORTS.—150 c.c.

FUNNELS.—6·5 cm.

DISTILLING FLASKS.—100 c.c., 250 c.c., 500 c.c.

EVAPORATING DISHES.—50 c.c., 100 c.c., 200 c.c., and, in smaller quantities, 1000 c.c., and 2000 c.c.

CRUCIBLES.—15 c.c. and 25 c.c.

In conclusion, the Joint Committee desires to express its strong conviction that every effort should be made to facilitate and encourage the manufacture of glass and porcelain apparatus in the United Kingdom. It therefore urges the advisability of asking the Board of Trade to watch the new industry, and, if necessity should arise, to use its endeavours to modify any restrictions at present existing which may be detrimental to the carrying on and extension of the industry.

(2) THE MANUFACTURE OF OPTICAL INSTRUMENTS AND MATTERS RELATING THERETO.

NECESSITY FOR ACTION.

The British Science Guild, having inquired carefully, by means of a strong and representative expert committee, into the effect of the outbreak of hostilities on matters of national importance connected with the manufacture of optical instruments in the country generally, submits this report to the Government, and in doing so emphasises the pressing urgency of the subjects referred to.

Supply of Glass. (*a*) *The General Case.*

(1) In the first place the inquiry referred to was directed to the consequences of the *sudden stoppage of the supply of German optical glass* on which this country had increasingly relied for many recent years. A letter of inquiry asking for information on six specific points was addressed to representative firms in the optical trade. The results of these inquiries has been such as to satisfy the guild that the supply of optical glass available for the manufacture of telescopes, binoculars, range-finders, and other service instruments is sufficient for the purpose. Under this head there seems to be no call for any special effort to improve upon existing conditions, though the *supply of English glass has not always been adequate in quantity, and delays have been experienced in obtaining quick delivery.*

The representative of Messrs. Chance Bros., who was a member of the Technical Committee referred to above, has assured the committee that since the outbreak of hostilities the firm has considerably increased (in fact, quadrupled) the capacity of its plant for the manufacture of optical glass, and is fully prepared to extend this plant still further.

(*b*) *Photography and Micrography.*

(2) With regard to the manufacture of photographic and microscopic lenses the case stands otherwise. The requirements of the manufacturing trade in these respects are not definitely standardised as in the case of the instruments already referred to. To facilitate new and important developments it is necessary that the lens manufacturer should have recourse to a greater variety of glasses than are, in fact, manufactured at the present time in this country. It is further necessary that larger stocks should be held than is the custom at the present time of the various glasses produced. The guild, therefore, is of opinion that serious inconvenience is certain to result to the manufacturing trade if the supply of German glass is cut off for any considerable length of time. The amount of glass demanded, especially for photographic purposes, is very considerable, and the guild is of opinion that the attention of the authorities might usefully be directed to this opportunity for a considerable development of British glass manufacture in this direction. One difficulty the guild understands to be the defective supply of pure barium compounds.

(*c*) *Variety of Glass Obtainable Inadequate.*

(3) From a wider point of view and more generally, the variety of English glasses offered is not sufficient for all the requirements of optical instrument-makers, especially for the more recently developed and important optical designs. Thus, whilst the leading English firm listed only twenty to thirty types of glass, the leading German firm listed about seventy types, every one stocked. Barium glass of high refraction and low dispersion, *i.e.* having a high value of the "anti-dispersion" coefficient, is reported as specially difficult to obtain in England.

Research.

(4) The desirability of the provision of facilities for research upon the manufacture of optical glass has been carefully considered and has been found to be a difficult question. From the evidence submitted it appears that if one special object of research could be attained the result would be highly advantageous. This object is the discovery of a refractory lining of the melting "pot" which would resist the action, at

melting temperatures, of the materials used in the glass mixtures, and leave the contents of the pot uncontaminated at the conclusion of the operation. This research would probably be a long and costly one, and is such as might most appropriately be undertaken by the National Physical Laboratory, especially as certain details in the manufacture of optical glass may come under review during the inquiry.

Authoritative Testing of Glass.

(5) In another direction evidence was submitted to the guild to the effect that it would be distinctly advantageous to the optical trade if *increased facilities for the authoritative determination of the optical constants* and *relative absorption of samples of glass* submitted for test could be provided at the National Physical Laboratory

THE FUTURE.

Facilities for Education a Matter of Great Urgency.

(6) In still another direction evidence, additional to evidence collected before the outbreak of hostilities, was elicited that the *facilities for education in technical optics are very inadequate.* It was shown that not only could some of the present difficulties connected with the supply of optical glass probably be diminished, but that the output of optical instruments for national purposes would be increased, and that the optical trade would be substantially benefited in other directions if such facilities were largely extended. The Technical Optics Committee of the guild was originally appointed, early in the year 1914, for the purpose of "inquiring into the need of an Institute of Technical Optics and the steps to be taken in connection therewith, and in due course it submitted a "statement" on the subject, which was published in the annual report of the guild, 1914, pp. 31–34. The committee had further reported to the Executive Committee of the guild at its July meeting, and the report was adopted with a few alterations, and is printed at the end of this report.

(7) When the Technical Optics Committee met after the vacation, the other matters, apparently of more immediate urgency, referred to in this report, had arisen and took precedence of the earlier matter. In investigating these new questions it has become strongly evident that the earlier matter is of *supreme and pressing importance.*

The guild therefore recommends:—

(A) That better provision should be made at the National Physical Laboratory for the testing of samples of glass as to their physical and optical properties, and that the director of the National Physical Laboratory be approached on the subject.

(B) That facilities should be provided as speedily as possible for the carrying out, at the National Physical Laboratory, or elsewhere, of the researches connected with the manufacture of optical glass referred to in this report.

(C) That steps should be taken as speedily as possible to give effect to the recommendations of the previous report of the Technical Optics Committee of the guild in the direction of providing facilities for systematic, scientific, and manual training in technical optics, and the guild, recognising that educational training requires time, is strongly of opinion that this question is urgent and that the organisation of optical training should be taken in hand at once.

PREVIOUS REPORT REFERRED TO IN PARAGRAPH C, DATED JULY 14, 1914.

Proposed Establishment of an Institute for Technical Optics.

The British Science Guild has had under consideration for some time the inadequate provision for, and the unsatisfactory state of, the technical training in optics in the British Isles. The subject was brought to its notice by Sir Thomas Barlow, formerly president of the Royal College of Physicians, in a communication to the president of the guild, and was considered to be of such importance by the Executive Committee that a Special Committee was formed to deal with it. The Special Committee has now reported.

The establishment of such an institute has been under discussion for some years, and there is a remarkable consensus of expert opinion, both as to the necessity and the urgency for action, from many and diverse points of view, scientific, industrial, and national.

The London County Council, which has gone into the matter very thoroughly, has not felt itself in a position to provide from the funds under its control the initial capital expenditure of some 40,000*l.* for the erection and equipment of the proposed institute, although a site was actually purchased for the very purpose by the governing body of the Northampton Polytechnic Institute so far back as 1908. The Finance Committee of the council is understood to be of opinion that the project is so essentially of national importance that it would be unfair to saddle London ratepayers with the whole cost. It is, however, believed that if the question of capital expenditure can be solved, the maintenance of the institute could be assured by grants from the Board of Education and from the London County Council, and by students' fees. As an additional reason for expedition, it may be pointed out that the governing body of the Northampton Polytechnic Institute may not be in a position to carry much longer the heavy burden of the mortgage interest on the purchase money above referred to, and the amortisation of the capital amount.

GEOLOGY IN RELATION TO THE EXACT SCIENCES, WITH AN EXCURSUS ON GEOLOGICAL TIME.[1]

IT is often said that figures can be made to prove anything; and certain it is that a series of arithmetical operations does sometimes serve as introduction to very strange conclusions. The fault, of course, is not in the tool, but in the hand that uses it. In the larger issues of geology especially, where the gulf to be bridged between data and conclusions is so often a wide one, ingenuity of reasoning ought surely to be accompanied by a due sense of responsibility in the handling of figures. Calculation, in such applications, is by no means so simple an art as it may appear. In wrestling with problems of the kind indicated, and, I must add, in reading some very fascinating speculations by geologists of high standing, I have often wished that some obliging mathematician would put forth a small manual of applied arithmetic for the guidance of workers in the descriptive sciences. There are absolutely necessary precautions to be observed when calculation is based upon data always partial and at best roughly approximate, and these precautions are too often neglected. To be safe, we must have some conception of the probable error attaching to our observations, and we must note how the initial errors may be multiplied in the process of calculation. Especially there is the cumulation of error which must ensue when results obtained in this fashion are used as links in a chain of deduction. Here it is quite inadequate to say that the chain is no stronger than its weakest link; it is of necessity far weaker than its weakest link.

[1] From a Presidential Address delivered before the Yorkshire Geological Society by Alfred Harker, F.R.S. Reprinted from the Proceedings of the Society.

Without entering into these matters, some of which, as I have suggested, call for expert aid, I will take for illustration a single point, the frequent abuse of *the average*. Say that we wish to determine the amount of mud annually carried down by the Nile. Since there are variations, both seasonal and casual, we must take a sufficient number of observations, properly distributed in time, and an average, duly weighted, will then give us as good a result as the nature of the case admits. But now suppose that we wish to know the amount of sediment carried by all the rivers of the world. We have data for nine rivers, data which are likely to differ much in respect of probable error. Accepting them, however, as they stand, it appears that the water of the Rio Grande carries one part in 291 of sediment, that of the Uruguay River only one in 10,000, the other seven rivers giving intermediate values. The highest figure is thus thirty-four times as great as the lowest. Some geologists will simply take a mean of the nine figures, and proceed contentedly to use this result in the most far-reaching conclusions. I do not believe that a mean of nine figures so discordant can afford any information of quantitative value. The average must be extended over a much wider area, before a result is obtained of which we can legitimately make use.

Where dynamical principles enter into the problem, the pitfalls which await the unwary are sometimes less evident. I will take as an illustration the case of models, such as have been constructed to elucidate the mechanism of folding and faulting. In no case, so far as I am aware, have geologists had regard to the conditions which are necessary in order that a model may correctly represent the working of the original. The various forces concerned must bear their proper ratios. Since the weight (for a given material) is reduced proportionally to the cube of the linear dimensions, the other forces must be reduced in the same ratio; and it is, in fact, impossible to make this adjustment as regards the internal forces which resist deformation and fracture. Moreover, the velocities of the moving parts should be reduced in proportion to the square root of the linear dimensions; and this makes it hopeless to think of imitating the slow processes of mountain-building. Models of this kind may afford useful *geometrical* illustrations, but can throw no light on *dynamical* problems. The same remark applies to models of glaciers; but here there is no need to go to artificial models to illustrate my point. Some geologists still argue from the behaviour of an Alpine valley-glacier to that of a continental ice-sheet, without perceiving how completely the different scale of magnitude must modify the mechanical conditions.

Experiment has undoubtedly afforded valuable help in the study of particular questions in the domain of physical geology, and this is to be recognised with gratitude. As regards the larger and more complex problems, however, imitative experiment labours under the same disadvantage as mathematical analysis. Any concrete problem can be treated only in an arbitrarily simplified form, and among the conditions which cannot be realised in the laboratory may be some which in nature are of vital importance. Especially will this be the case where the time element enters.

There is, however, another department of experimental geology in which we are justified in expecting results of very high value. I allude to the study of the conditions of formation and stability of different minerals, with the object of elucidating the mode of origin of igneous and other rocks. The artificial reproduction of many of the rock-forming minerals has engaged the attention of chemists, especially in France, during the last hundred years. Fouqué and Michel-Lévy succeeded even in imitating some of the simpler types of igneous rocks. These researches have furnished the petrologist with useful information, but it is information mostly of a very general kind. The laborious investigations now being carried out, more particularly in the Geophysical Laboratory of the Carnegie Institution of Washington, are of a different order, systematic and precise to the highest degree attainable. Their chief object is to apply to the crystallisation of igneous rock-magmas the methods which have proved so fruitful in other branches of physical chemistry. This necessitates working over a far wider range of temperatures than is usual in laboratory operations, and must sometimes include high-pressure work also. It involves, too, other practical difficulties, arising especially from the slowness with which equilibrium is established in many of the transformations investigated. Owing perhaps to these obstacles, and partly, it may be, to the scarcity of enlightened millionaires—for expense is here a weighty consideration—research on these lines has not yet been widely taken up. Meanwhile it is scarcely too much to say that Dr. Day and his colleagues at Washington are already laying the foundations of an exact science of petrogenesis.

Of all geological questions involving the numerical element, none has been more frequently canvassed than the problem of geological chronology, and none has excited more general interest. Since, moreover, it introduces several points germane to my subject, a brief glance at its history and present state will not be wasted. I suppose it has happened to most of us, when relating how in past times the mammoth roamed the plains of Holderness, or how coral-reefs once flourished where the Craven hills now stand, to be met by the inquiry: How long ago was that? The answer was perhaps to the effect that geology does not deal with the ordinary measures of time, but has its own system of chronology, not translatable into years and centuries. I must confess, however, to a sense of inadequacy in such a reply, and some sympathy with the lay inquirer who is thus silenced but not satisfied. It seems a matter of reasonable regret that a science which deals with the history of past events should have no definite time-scale, by which those events could be ranged in a correct perspective.

No such reflection, it is safe to say, disturbed the minds of the early Uniformitarians, the founders of modern geology. Their reaction against the older catastrophic school led them constantly to lay great stress on the extreme slowness of geological processes, and they thus came to assume unlimited time for the past changes to which the stratified rocks bear witness. To Hutton there was "no vestige of a beginning, no prospect of an end"; in other words, he regarded geological time as infinite, and could no more contemplate reckoning it in centuries than numbering the sands on the shore. Later this position was reinforced from another quarter, as Darwin's doctrines gained acceptance; for these were held to push back to an immeasurably remote epoch the beginning of life on the globe. Geologists and biologists alike saw no reason for limiting their prodigal drafts on the bank of time.

From this comfortable attitude they were startled, as by a bombshell, some fifty years ago, when William Thomson, afterwards Lord Kelvin, published the first of his contributions from the mathematical side to this and cognate subjects. He pointed out that, apart from any changes on the surface of the globe, our planet as a whole must be undergoing a change of a secular, and so irrevocable, kind; viz., a continual loss of energy in the form of heat, as proved by the observed temperature-gradient. Since the store of energy cannot be inexhaustible, we must deduce both a beginning and

an end of the existing geological *régime;* and Thomson endeavoured to set a limit to its past duration from a discussion of the rate of cooling of the globe. A parallel line of argument was based on the cooling of the sun.

Now as regards the validity of the general criticism there can be, of course, no doubt. Huxley's halting defence of what was then the orthodox position was easily broken down, and a wholesome check was given to the extravagance of the geologists. When we turn, however, from the destructive to the constructive part of Kelvin's argument, the case is different. The time to be allowed for the geological record was stated at first with considerable latitude, but was afterwards narrowed down, until, in 1899, Lord Kelvin concurred in Clarence King's conclusion that the globe was a molten mass about twenty-four million years ago. It is rather remarkable that so many geologists were found willing to submit to this narrow limitation. Doubtless they were impressed by the prestige of Lord Kelvin's authority, and perhaps some of them were influenced by a vague feeling that a result arrived at by strict mathematical reasoning is thereby entitled to credence. But, as has been so often pointed out, and so often forgotten, what you get out of the mathematical mill depends upon what you put into it. The reasoning may be unimpeachable, but it merely proves that, if certain assumptions be granted, certain consequences will follow. It may be that Lord Kelvin himself, in the enthusiasm of enforcing his conclusions, did not always recall the foundations on which they rested, and it is to be suspected that many geologists read no more than the conclusions.

Kelvin's argument was based necessarily upon a number of assumptions. At the present time, in the light of fuller knowledge, it is sufficient to note one, which in 1862 seemed little open to question. Kelvin recognised that, while the earth is certainly losing heat, "it is possible that no cooling may result from this loss of heat, but only an exhaustion of potential energy, which in this case could scarcely be other than chemical affinity between substances forming part of the earth's mass." This, however, he dismissed as "extremely improbable," and proceeded on the assumption that heat is the only form of energy to be reckoned with. Since the discovery of radium we have learnt that the earth possesses a vast store of potential energy in a highly concentrated form then unsuspected. Strutt has calculated, from data of a very simple kind, that the observed temperature-gradient can be wholly accounted for by radio-activity, if the rocks to a depth of forty-five miles contain as much radium as those at the surface. In other words, the heat generated by radio-active changes within this relatively thin crust will, on that supposition, be sufficient to compensate that lost at the surface. Clearly, therefore, the actual rate of cooling of the globe—if indeed it is cooling—must be far less than that adopted in Kelvin's calculation, and his estimate of the age of the earth must be enormously increased.

This is not all. A study of the various radio-active elements contained in minerals and rocks has shown that it is possible, in certain favourable cases, to calculate directly their age in years. Some estimates of this kind have been made, and the results are liberal enough to satisfy the most exacting claims of what may be called the reformed Uniformitarian creed.

With this turning of the tables one might suppose that the old controversy would come to an end. But the reversal of the situation is, in fact, more complete; for meanwhile there has arisen a formidable minority of geologists who contend, on geological grounds, for estimates of time no more elastic than Lord Kelvin's. The question is still, in great part, one between geologists and physicists, but it is now the geologists who offer us the stinted measure and the physicists the more liberal one.

It is not my purpose to discuss in detail the various geological arguments which have been advanced for limiting the age of the earth to a span of 80 or 100 millions of years. The method of procedure is broadly the same in all. A computation is made of the rate at which some fundamental geological process is going on; it may be the lowering of the land-surface by erosion, or its destruction by solution, or the deposition of sediment, or the addition of salt to the sea. Some estimate is then made of the total result of the process throughout geological time. Having the annual rate of increment and the total amount, simple division gives the measure of the time in years. The observational data employed in these calculations are of a very precarious kind, and it would not be difficult to point out instances of that levity in the handling of figures to which I have adverted. But the fundamental weakness of all such reasoning lies in the assumption that the present rate of any of these geological processes can be adopted as equivalent to its average rate throughout the whole time.

The existing configuration of the globe, and all the physical conditions that go with it, have been attained in consequence of a prolonged evolution. If we believe that, as the net result of all its vicissitudes, the land-area has on the whole been growing in extent, in complexity of distribution, in boldness of relief, we must believe also that differences of temperature, of humidity, of climate generally, between different parts of the globe have become progressively more accentuated, and that all geological activities have been quickened as the world has grown older. While there is difference of opinion concerning these *secular* changes, there can be no doubt as regards the great *cyclical* changes which have been repeated several times in the history of the earth: the cycle beginning in each case with an epoch of important crust-movements and including the train of consequences which follow upon this new step in the evolution of the earth. Such a cycle was initiated at an epoch not long remote by geological reckoning, and we are living in consequence in a time of more than ordinary geological activity, with the continental masses rising higher than their average level, and with large tracts of newly deposited strata exposed to the attack of destructive agents.

For these reasons I am of opinion that the present rate of erosion, and of its correlative sedimentation, is much higher than the average rate, and that any calculation based upon it must greatly under-estimate the duration of geological time. I do not ask you necessarily to concur in this conclusion, but at least to suspend judgment in the matter: for it will assuredly be a misfortune if geology, so lately freed from one bondage, should fall straightway into another no less galling. This at least is certain, that every one of the various geological processes which have been discussed in this connection, is controlled by conditions which cause its rate to be very variable. It is a clock which now hurries and now creeps, or stands still, and it can never be trusted as a time-keeper. Even for the most recent chapter of geological history we can make no approach to certainty on these lines. Attempts have been made, for example, to estimate the time since the final retreat of the ice in North America from the rate of recession of the falls of Niagara; but the evidence shows that this rate has varied widely even during the last half-century, and Gilbert, after a careful study of all the data, refrains from offering any opinion on this point.

Must we then abandon all hope of any practicable

measure of time in geology? I do not draw this conclusion, but rather that we must search outside strictly geological phenomena for some physical process of which the rate is not affected by any disturbing conditions. There are, I think, only two classes of changes for which so much can be claimed—the transformations of the radio-active group of elements and the astronomical movements. It seems not improbable that in one or other of these two directions the solution of the problem may eventually be found.

The chemists have taught us that radium is derived from the spontaneous breaking up of uranium, the change taking place apparently in two stages and involving the liberation of three atoms of helium. But radium itself disintegrates spontaneously, giving the radium-emanation named niton and liberating another atom of helium. Niton in its turn undergoes disintegration, and so on through a succession of changes. The final product is lead, and in the gradual conversion of uranium to lead eight atoms of helium in all are set free. Of these various spontaneous changes some proceed with extreme slowness, others with comparative rapidity; but in each case there is a constant rate which, so far as experiment has tested it, is independent of temperature or pressure.

Prof. Strutt has shown that this gradual liberation of helium can be made the basis of a method of estimating the absolute ages of minerals and rocks. For example, phosphates and some iron-ores are rich in radium, derived from uranium. They also contain helium, and the ratio of helium to uranium is found to be higher in the older deposits. Estimates of age calculated from these data give high figures: *e.g.* the age of the hæmatite overlying the Carboniferous Limestone in Cumberland is given as 140 millions of years, and even that of the Eocene iron-ores of Antrim thirty millions. The results show some irregularities, and it is, of course, admitted that the method has its own difficulties. If, however, the chief source of error is, as appears probable, the loss of helium by leakage, the figures found will be under-estimates. Helium comes from the thorium series of derivatives as well as from the uranium series, and this is to be taken into account where thorium is found. Zircons from various igneous rocks have also been examined by Strutt, and found to give consistent results as regards the helium-ratio. Mr. A. Holmes has approached the question in a different way, by considering the ratio of lead to uranium in various minerals rich in the latter element. The igneous rocks of the Christiania district, of Devonian age, are in this way calculated to be about 370 million years old. For the Archæan rocks of different countries the estimates range from 1000 to 1600 millions of years. Holmes's results are in general nearly twice as high as those of Strutt; but, if we bear in mind the error due to the escape of helium, which is proved to take place, a discrepancy to this extent is no more than should be expected at this early stage of the inquiry.

The other method which has been suggested for obtaining an absolute measure of geological time is of a more speculative kind, although the principle of it is sufficiently simple. It consists in detecting some clearly marked rhythm or cycle in the geological record, and correlating it with one of the known periodic movements of the earth. It was on these lines that Croll attempted to explain the recurrent glacial epochs; but more to our present purpose is the theory which Blytt has based upon a study of the alternations observed in a succession of sedimentary strata. The most important astronomical cycle of long period is doubtless that which depends upon the precessional movement, by which the relation of summer and winter to perihelion and aphelion is gradually changed. This involves a change in the relative lengths of summer and winter, and must undoubtedly exercise a marked effect upon climatic conditions, though there is much difference of opinion concerning the exact nature of this effect. Changes of climate may in their turn cause differences in the nature of the sediments deposited successively at a given place, differences which will repeat themselves in a cycle corresponding with that of the precession. Probably the most noticeable effect will be a recurrence of limestones and chemical deposits alternating with detrital sediments.

If the matter were no more complex than this, it would be sufficient, where such alternations can be detected, to count them, as we count the rings of growth of a tree, and reckon 21,000 years for each sedimentary cycle, that being the period of the precession corrected for the movement of the perihelion. If the alternations can be distinguished only in some parts of the succession, some hypothesis must be devised to take account of the intervals. Gilbert has discussed in this way a succession of beds, 3900 ft. thick, forming part of the Cretaceous system in Colorado. Alternations of calcareous beds with shales come in four times, being separated by unbroken thicknesses of shale. Gilbert calculates for the part of Cretaceous time represented a duration of about twenty million years, with an uncertainty indicated by the number 2 as a "factor of safety."

We have to remember, however, that sedimentation is controlled by other conditions besides climate, and climate depends upon other causes besides the precession of the equinoxes; and, further, that most of these contributing causes cannot be described as periodic in any intelligible sense. There is, it is true, a second astronomical movement to which both Croll and Blytt have made appeal, viz., the variation in the eccentricity of the earth's orbit. This goes through a period of about 90,000 years; but there are considerable irregularities which repeat themselves in the course of 1,450,000 years, giving a larger cycle which embraces sixteen of the smaller cycles. The change of eccentricity must modify the effect of the precessional movement; but Blytt argues that it will also react on the ellipsoidal shape of the globe itself, and so give rise to a displacement of shore-lines. He claims to have traced this effect, as well as the climatic cycle, in such cases as the succession of the Tertiaries in the Paris basin and the Isle of Wight. His conclusion is that Tertiary time comprises two of the larger cycles, *i.e.* about three million years.

It has usually been assumed that the year is too short a period to leave any recognisable mark on the geological record. This is probably true in general, but in certain favourable circumstances it may perhaps be possible to count annual layers of sediment. De Geer has recently attempted this in the case of certain finely laminated clays of late Glacial and post-Glacial age in Sweden. The material was brought down by sub-glacial streams at a time when the ice had retreated to the higher ground. Consequently the seasonal variations were strongly marked, and the accumulation of sediment was rapid enough to yield an appreciable thickness in each year. From such data De Geer has estimated that the recession of the last ice-sheet occupied a duration of about 5000 years; and he further gives 7000 years as the lapse of time since the recession of the ice.

As regards the longer astronomical cycles, it is clear that the argument involves a large element of hypothesis, and its application, as Blytt allows, is beset with practical difficulties. It possesses a special interest as lending a new significance to the details of stratigraphy, but as a means to the establishment of a

geological chronology its value is at present only potential. The radium method of evaluating geological time seems to offer more immediate promise.

In conclusion, it is pleasant to note how these applications of chemistry, astronomy, and meteorology, not merely to general principles of geology but to a definite geological problem, emphasise the fundamental unity of the sciences, and illustrate the powerful aid that may be rendered by one to another.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. ROY DEAN, professor of pathology in the University of Sheffield since 1912, has been appointed to the chair of pathology and pathological anatomy in the University of Manchester.

DR. ADA E. MILLER has been appointed lecturer on school hygiene by the Edinburgh Provincial Committee for the Training of Teachers, in succession to Dr. I. Douglas Cameron, who has resigned.

IT is stated in *Science* that the committee on education of the United States House of Representatives has reported favourably a Bill establishing a National University in Washington. According to the Bill an initial grant of 100,000*l.* would be made. The university would be devoted to research and graduate work and no degrees would be conferred.

A REUTER message from Delhi reports that on March 22 Sir Harcourt Butler introduced in the Imperial Legislative Council a Bill for constituting a teaching and residential university at Benares, with special facilities for instruction in the Hindu religion. He referred to the scheme as the commencement of a new era in university organisation in India.

DR. ALEX. HILL, principal of the Hartley University College, Southampton, is reported by the *Times* to have said in an address on Monday that he had recently been preparing a war-roll of the Empire universities, and had found that the average contribution in men from universities and university colleges was just above 50 per cent. He added:—"It is a surprising fact that the contribution of German universities to the forces of the German Empire in the field is less than 20 per cent." This statement as to German university students is not, however, correct, judging from the statistics we gave last week (p. 81). Seventy-five per cent. of the students of German universities are in the field, and about 80 per cent. of the students of the Technical High Schools are also on active service.

SIR PHILIP MAGNUS retires, we understand, to-day from his official connection with the City and Guilds of London Institute. It is now no fewer than thirty-five years ago since he was appointed organising director and secretary of the institute, a post which he held for eight years, during which he was responsible for the initiation of the institute's work and for the schemes of the Finsbury College and Central Technical College, which have since developed so successfully. In 1888 his activities were transferred to the examinations department, or, as it is now known, the department of technology of the institute, where they found a wider field in assisting and guiding the development of technical instruction all over the country. The ability of his organising powers is sufficiently evidenced by the manner in which the department, without any assistance from Government and without the power of the purse possessed by a department of State, has made the name of the City and Guilds of London Institute known to technical schools all over the British Isles, and, indeed, in the Dominions beyond the Seas. To the work of Sir Philip Magnus in the office which he is vacating, his careful insistence on the necessity of making technical instruction a true education in principles, his continual study of the best means of adapting courses to the needs of students and manufacturers alike, and his unceasing endeavours to raise the standard of teaching, the progress of technical education in this country is greatly indebted.

THE first annual report, for the period ended December 31, 1914, submitted by the executive committee to the trustees of the Carnegie United Kingdom Trust has now been published. Mr. Carnegie during many years prior to 1912 gave large sums to local authorities in this country for the erection of public libraries, and to churches for the acquisition of organs. As the applications for these grants increased and their administration became more difficult, Mr. Carnegie decided to place the future administration of grants under the control of a permanent body of trustees. In 1913 he placed 2,000,000*l.* in trust so that the income of about 100,000*l.* a year should be available "for the improvement of the well-being of the masses of the people of Great Britain and Ireland." The report is full of interesting particulars, but attention can be directed only to a few typical facts. Organ grants are to be discontinued for the present. Mr. Carnegie has already expended 550,000*l.* in this direction in the acquisition of some 3500 instruments. A total expenditure of nearly 2,000,000*l.* has been incurred already on the erection of public libraries in the United Kingdom. The executive committee has, we notice, intimated to the authorities of the Household and Social Science Department of King's College for Women, London, that it is prepared to meet half the cost of the erection of a library building, on certain conditions. The committee has also made an offer in the direction of endowment to the Central Bureau for the Employment of Women. The report throughout gives the impression of wise and sympathetic administration of a princely endowment.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 18.—Sir William Crookes, president, in the chair.—Prof. W. H. **Bragg**: Bakerian Lecture: X-rays and crystalline structure. The atoms of crystal may be conceived—in various ways—as arranged in a series of parallel planes, each capable of reflecting a small fraction of an incident pencil of X-rays. If the spacing of the planes is d, the wave-length λ, and the angle between the rays and the planes is θ, and if the relation $n\lambda = 2d \sin\theta$ is satisfied, where n is any integer, then the various reflected pencils are in the same phase and combine to give an obvious reflection of the X-rays. If this relation is not satisfied there is no reflection. The X-ray spectrometer is designed to measure the various values of θ at which reflection occurs in a given case. The angle can easily be determined to a minute of arc. Given d we can compare the wave-lengths of different X-rays. Given λ we can compare the spacings of various sets of planes of the same or of different crystals. By certain considerations the experiments can be made absolute and not merely comparative. In this way the structures of several simple crystals have already been found, such as rock-salt, diamond, iron pyrites, and so on. The reflections for various values of n, the

integer in the formula, or, as they may be called, the spectra of various orders, differ amongst themselves in a surprising way. The intensities in the case of the most important planes in Iceland spar have recently been determined and give very interesting results. In the case of two pairs of planes the spacing is the same but the arrangement of atoms is different. This gives an opportunity of comparing the effect of arrangement apart from spacing, and it appears that the *intensity* of the reflection in any order is proportional to the weight of the planes which contribute to that order. Again, there are three calcite planes for which the arrangement of the atoms is exactly the same, but they differ in their spacings. The relative intensities follow a rule which has already been stated, viz., that the intensity in a reflection at an angle θ is inversely proportional to $\sin^2\theta$, other things being the same. Rules of this kind are needed if the method is to be used in the examination of more complicated crystals. The physical meanings that may be attached to these rules are of considerable interest.

Physical Society, February 26.—Dr. A. Russell, vice-president, in the chair.—Dr. C. **Chree**: Magnetic "character" figures, Antarctic and international. The paper makes use of magnetic "character" figures "0" (quiet day), "1" (moderately disturbed day), "2" (highly disturbed day) to investigate whether the incidence of disturbance at the base station of the Scott Antarctic Expedition, 1911–12, did or did not accord with the incidence of disturbance in temperate latitudes; also whether the "27-day period" could be recognised in the Antarctic data. The incidence of disturbance in the Antarctic was found to agree closely with that shown by the international lists, in spite of the fact that the disturbances in the Antarctic were much larger and more persistent than at any of the stations co-operating in the international scheme. The "27-day period" was clearly visible in the Antarctic records both in summer and winter, being as well developed there as elsewhere.—Dr. P. E. **Shaw**: The electrification of surfaces as affected by heat. The paper deals with anomalous electrical behaviour of various substances when subjected to heat. For example, a glass rod rubbed with silk is normally left positively electrified, but if the rod be passed through a bunsen flame, or heated in an electric furnace, and then allowed to cool it will be found on again rubbing with the silk that the glass becomes negatively electrified. Similar results were obtained with a number of materials, and various experiments are described which aim at determining the cause of the phenomenon. These seem to show that it is not due to the formation or removal of layers of any substance, solid or gaseous, but is probably due to surface strains in the material.—Prof. J. W. **Nicholson**: Electromagnetic inertia and atomic weight. The paper contains a mathematical deduction of a simple formula for the combined mass of two electrical charges when in proximity to each other. This mass is not the sum of their individual masses when far apart, if it be supposed that all mass of positive electricity, like that of electrons, is of electromagnetic origin. Applications are made of the formula to questions of atomic constitution and of radio-activity. A discussion is given of the evidence leading to the conclusion that the nuclei or cores of positive electricity in atoms are complex structures of electrons and even smaller positive nuclei. On this basis, emission of an α particle by an atom does not decrease its atomic mass by 4, a correction being necessary for the "mutual mass" of the α particle and the rest of the core. Estimates of the magnitude of this correction, in the case of radium and thorium passing into lead by the emission of particles, are given. From the value given by Soddy for the atomic weight of thorite lead we can deduce the average distance apart of the components in a radium nucleus. It is of the same order as the radius of an electron. Suggestions of further interesting applications of the precise formula for mutual mass are also contained in the paper.

March 12.—Dr. A. Russell, vice-president, in the chair.—C. C. **Paterson** and B. P. **Dudding**: The estimation of high temperatures by the method of colour identity. Preliminary experiments are described in which the temperature of incandescent substances is estimated with a very fair accuracy by matching their colour with that of incandescent filament lamps working at appropriate efficiencies. These have previously been calibrated by comparison with a "black body" over a large temperature range. The comparisons are made in the field of a Lummer Brodhun photometer, and the method is shown to give the correct result for the melting point of platinum.—C. C. **Paterson** and B. P. **Dudding**: The unit of candle-power in white light. The paper describes the methods adopted at the National Physical Laboratory for minimising the difficulty of photometric comparison of white lights of different hue. A series of six sets of electric substandards are described varying in the tint of the light radiated from that of the pentane lamp to that of a tungsten vacuum lamp operating at 1·5 watts per candle. The absolute value of the unit of candle-power has been re-determined, as have also the corrections for humidity and barometric changes, while the probable existence of a temperature correction is discussed.—G. L. **Addenbrooke**: The relative losses in dielectrics in equivalent electric fields, steady and alternating (R.M.S.). After references to former work, especially on surface leakage, tables are given showing an intimate connection between the losses in steady and alternating fields, and that one can be predicted from the other to a first approximation. Exceptions are mentioned, and it is shown that there is heterogeneity in these cases. Curves of the losses from 1 to 4 seconds to 40 ~ are given for specimen dielectrics. Above 8 to 12 ~ both for "good" and "poor" dielectrics, these become rising straight lines. The salient features lie below about 16 ~. The formula $a+bn$ applies to all dielectrics for frequencies above about 8 ~, but not below. The a constant is always larger than, and bears only a very indefinite relation to, the steady voltage loss. Liquid dielectrics behave similarly to solid with certain differences, particularly that for a given resistance the ratio of the steady to the alternating loss is less than with solids. There is a great difference in the comparative ranges of the losses. For the dielectrics tabulated these vary in a steady field from 1 to 1,300,000, but the corresponding alternating losses vary only from 1 to 1,100.

Linnean Society, March 4.—Prof. E. B. Poulton, president, in the chair.—A. W. **Hill**: The germination of the cucurbitaceous genus Marah. The genus Marah includes some eleven species practically confined to the Pacific watershed of the western States of North America and the islands of Lower California. The genus is distinguished from Echinocystis and other genera with similar floral characters by its enormous tuberous root, associated with which is the peculiar mode of germination of the seeds. The petioles are fused to form a tube, and on germination this tube grows out, carrying plumule and radicle some distance into the ground, the cotyledons remain-

ing hypogeal. The plumule finally bursts through the petiolar tube, and grows up into the air with sharply bent over tip. The petiolar tube is covered with hairs which appear to function as root-hairs.—Dr. Marie C. **Stopes**: New types of stem-anatomy in Cycadeoidea, with a well-petrified new species. A short account was given of two species of Cycadeoidea in which the internal anatomy is partially preserved, and also of a well-petrified new species showing very curiously alternating series of wood zones.—W. E. **Collinge**: A new genus and species of terrestrial Isopoda from British Guiana.—Dr. **Stapf**: Inflorescences of the Carob tree (*Ceratonia siliqua*) representing the several sexual conditions in which the tree occurs. Reference was made to Cavanilles's observations in the Carob groves of Valencia and the work done by Heckel and Schlagdenhauffen on the French Riviera, and by Gennadius in Cyprus. According to these authors most of the apparently female trees, that is, trees with very small subsessile anthers, are in reality hermaphrodite (brachystemonous hermaphrodites in contradistinction from the rare dolichostemonous hermaphrodites). But Dr. Stapf pointed out that no anthers containing pollen could be found in the "brachystemonous" specimens in the Kew Herbarium, in spirit material recently received from the Italian Riviera, and in preparations of such flowers obtained from Cyprus. In spite of Heckel's, Schlagdenhauffen's, and Gennadius's excellent work, there is still some mystery surrounding the pollination of the Carob tree which is certainly worth studying on the spot.

Zoological Society, March 9.—Mr. R. H. Burne, vice-president, in the chair.—R. I. **Pocock**: The feet, perfume-glands, and other external characters of the Viverrinæ. The term Viverrinæ was used by the author in a restricted sense for the typical Civets and Genets referred hitherto to the three genera, Viverra, Viverricula, and Genetta. He pointed out, however, that a new generic term must be introduced for the African Civet (*V. civetta*), which differs from the Oriental species (*V. zibetha*), the type of the genus Viverra, in the presence of a small metatarsal pad, the absence of skin-lobes protecting the claws on the fore-feet, the nakedness of the area of the feet round the plantar pad, the structure of the perfume-gland, etc.—Mary L. **Hett**: New Pentastomids from the lungs of snakes. The snakes from which the material was obtained had died in the society's gardens. There is great difficulty in establishing diagnostic characters for the separation of species in the Pentastomids. Size and number of annulations have generally been used as standards of comparison and they hold good in a certain number of cases; but in many forms both these characters are so variable as to afford no sound basis for classification. This is illustrated by *Porocephalus bifurcatus* and three allied forms which are here described as varieties. They were all obtained from the lungs of snakes from different regions. An average specimen of each form differs from the other varieties in length and number of rings, but intermediate forms occur which almost bridge the gap between them in both particulars. Hence it is difficult to regard them as separate species. If, however, the differences should prove to be of specific value, the four species, together with one other, should certainly be united in a new genus, as they differ from all other Pentastomids and resemble one another in several important particulars.—Reports on the collections made by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea:—G. J. **Arrow**, G. A. K. **Marshall**, and C. J. **Gahan**: Coleoptera.—F. W. **Edwards** and E. E. **Austen**: Diptera.—H. **Campion**: Odonata.—Dr. L. Cognetti de **Martiis**: Vermes.—G. **Arnold** and Dr. C. L. **Boulenger**: The fresh-water Medusa recently discovered in the Limpopo River system. This jelly-fish is referred to the same species (*Limnocnida rhodesiae*, Boulenger) as the form described from a tributary of the Zambesi River in 1912. Species of Limnocnida are now known to occur in the five principal river systems of Africa as well as in the Bombay Presidency of India. The paper contains descriptions of the structure and habits of the jelly-fish, and attention is directed to the occurrence of parasitic Infusorians of the genus Trichodina on both the African species, *L. tanganicae* and *L. rhodesiae*.—F. F. **Laidlaw**: Bornean dragon-flies collected on Mount Kina Balu. Two new genera and seven new species were described.

Geological Society, March 10.—Dr. A. Smith Woodward, president, in the chair.—C. **Reid**: The plants of the late Glacial deposits of the Lea Valley. Large collections of plants from the Lea Valley deposits, already described, have been made by Mr. S. H. Warren, Mr. E. T. Newton, and Mr. Wrigley. The localities from which the plants were obtained are Angel Road, Hedge Lane, Ponders End, and Temple Mills. A list from Ponders End has already been given by Dr. Lewis, but the new collections include many unrecorded species, several of which have not previously been noted as British fossils. Although there are slight differences, the collections from all four localities are so similar as to leave no doubt that the deposits are contemporaneous. The whole assemblage points to a very cold climate, though perhaps not quite so cold as that indicated by the Arctic plants found at Hoxne, in Suffolk. Among the more interesting novelties may be mentioned *Armeria arctica*, a species of thrift now confined to Arctic America, although it has also been recorded as a Pleistocene fossil from the continent of Europe by Dr. C. A. Weber.—S. **Smith**: The genus Lonsdaleia and *Dibunophyllum rugosum* (McCoy). The present paper discusses the literature, structural characters and development, descent, classification, and distribution of the corals constituting the genus Lonsdaleia; it includes also a description of *Dibunophyllum rugosum* (McCoy).

Royal Meteorological Society, March 17.—Dr. W. G. **Duffield**: The meteorology of the sun. An account was given of methods and results of spectroscopic and other observations of solar phenomena. Abbot's work on the variability of solar radiation opens up the prospect of further discoveries in connection with solar and terrestrial phenomena, the most important practical problem in the region of physics or meteorology. It is the hope of astronomers that the earth will be completely girdled by observatories which will take part in the international scheme of co-operation in solar research. The promise of such observatories in Australia and New Zealand is welcomed by all interested in the development of solar and terrestrial meteorology.

BOOKS RECEIVED.

Elementary Human Biology. By J. E. Peabody and A. E. Hunt. Pp. xii+194. (London: Macmillan and Co., Ltd.) 4*s*.

The Chemistry of Paints and Painting. By Sir A. H. Church. Fourth edition. Pp. xx+388. (London: Seeley, Service, and Co., Ltd.) 7*s*. 6*d*. net.

Elementary Electricity and Magnetism. By W. S.

Franklin and B. MacNutt. Pp. viii+174. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 1.25 dollars net.

Advanced Theory of Electricity and Magnetism. By W. S. Franklin and B. MacNutt. Pp. vii+300. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 2 dollars net.

The Mathematical Analysis of Electrical and Optical Wave-Motion on the basis of Maxwell's Equations. By Dr. H. Bateman. Pp. vi+159. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

A Treatise on the Theory of Alternating Currents. By Dr. A. Russell. Vol. i. Second edition. Pp. xiv+534. (Cambridge: At the University Press.) 15*s.* net.

Zoology. By Dr A. E. Shipley and Prof. E. W. MacBride. Third edition. Pp. xx+752. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

The Story of Plant Life in the British Isles. By A. R. Horwood. Vol. iii. Pp. xvi+514. (London: J. and A. Churchill.) 6*s.* 6*d.* net.

Explosives: Their Manufacture, Properties, Tests, and History. By A. Marshall. Pp. xv+624. (London: J. and A. Churchill.) 24*s.* net.

Dyestuffs and Coal-Tar Products: Their Chemistry, Manufacture, and Application. By T. Beacall, Dr. F. Challenger, Dr. G. Martin, and Dr. H. J. S. Sand. Pp. vii+156. (London: Crosby Lockwood and Son.) 7*s.* 6*d.* net.

British Birds. By A. Thorburn. In 4 vols. Vol. i. Pp. viii+143. (London: Longmans and Co.) 6*l.* 6*s.* 4 vols.

The Minor Horrors of War. By Dr. A. E. Shipley. Pp. xvii+166. (London: Smith, Elder and Co.) 1*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 25.

ROYAL SOCIETY, at 4.30.—The Production of Growths or Deposits in Meta-stable Inorganic Hydrosols: Prof. B. Moore.—Forms of Growth resembling Living Organisms and their Products slowly deposited from Meta-stable Solutions of Inorganic Colloids: Prof. B. Moore and W. G. Evans.—A Contribution to our Knowledge of the Chemistry of Coat-Colour in Animals and of Dominant and recessive Whiteness: H. Onslow.

ROYAL INSTITUTION, at 3.—The Ground beneath London: Dr. A. Strahan.

CHILD STUDY SOCIETY, at 6.—The Care of the Teeth: C. E. Wallis.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephone Troubles in the Tropics: W. L. Preece,

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—A Contribution to the Theory of Propulsion and the Screw Propeller: F. W. Lanchester.—A Comparison between the Results of Propeller Experiments in Air and Water: A. W. Johns.—Further Model Experiments on the Resistance of Mercantile Ship Forms: The Influence of Length and Prismatic Coefficients on the Resistance of Ships: J. L. Kent.—At 3 p.m.—The Law of Fatigue Applied to Crankshaft Failures: C. E. Stromeyer.—The Effect of Beam on the Speed of Hydro-Aeroplanes: L. Hope.—Notes on the Cross Curves and GZ Curves of Stability: E. F. Spanner.

FRIDAY, MARCH 26.

ROYAL INSTITUTION, at 9.—Experiments in Slow Kathode Rays: Sir J. J. Thomson.

GEOLOGISTS' ASSOCIATION, at 8.—On the Structure of the Eastern Part of the Lake District: J. F. N. Green.

PHYSICAL SOCIETY, at 5.—The Change of Thermal Conductivity with Fusion: Prof. A. W. Porter and F. Simeon.—An Instrument for the Optical Projection and Delineation of Physical Curves, such as Hysteresis, Resonance and Characteristic Curves (with experiments): Prof. J. A. Fleming.—The Stability of Some Liquid Films: Dr. P. Phillips and J. Rose-Innes.—A Demonstration of the Green Flash at the Setting of an Artificial Sun will be given by Prof. A. W. Porter and E. T. Paris.

SATURDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Recent Researches on Atoms and Ions: Sir J. J. Thomson.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Annual Meeting.—The Dating of Early Human Remains: S. Hazzledine Warren.—Notes on Palæolithic Implements from Wanstead Park: C. H. Butcher.

MONDAY, MARCH 29.

ROYAL SOCIETY OF ARTS, at 8.—House Building: M. H. Baillie Scott.

INSTITUTE OF ACTUARIES, at 5.—Two Notes on Questions of Office-Practice: R. Todhunter.

TUESDAY, MARCH 30.

ROYAL SOCIETY OF ARTS, at 4.30

WEDNESDAY, MARCH 31.

INSTITUTION OF ELECTRICAL ENGINEERS, at 7.45.—Students' Section.—Some Notes on High-tension Overhead Transmission Lines: E. T. Driver.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Estimation of Methyl Alcohol in Presence of Ethyl Alcohol: G. C. Jones.—Note on the Determination of Niobium in presence of Tantalum, and some reactions of Tantalum Compounds: A. G. Levy.—Estimation of Carbon Dioxide in Self-raising Flours and Baking Powder: T. Macara.—Bromine Method of Determining Phenol: W. Versfeld.—A Method for the Determination of Chlorine in Cheese: Miss E. C. V. Cornish and J. Golding.

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